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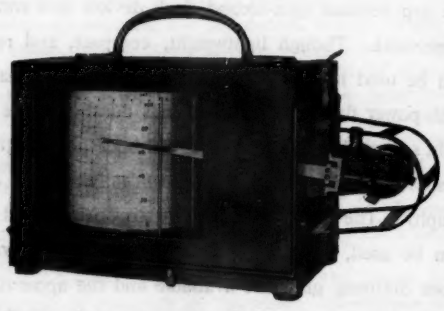

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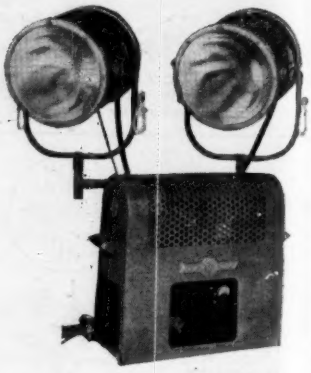

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CONTENTS

	Page
Universities as Research Centres	83
Dynamics of Co-operation. By E. F. L. Brech	85
Levels of Abstractness in Mathematics. By Dr. F. Smithies	86
Letters of Benjamin Rush. By Sir Philip Manson-Bahr, C.M.G.	87
X-Ray Analysis for Honours Students. By Dr. A. J. C. Wilson	87
The Magnetic Amplifier. By Prof. James Greig	88
Handbook of Diseases of North American Plants. By D. E. Green	88
Research on Marriage. By Kenneth Walker	89
Ultra-Violet Injury to Higher Plants Counteracted by Visible Light. By F. C. Bawden, F.R.S., and A. Kleczkowski	90
Deficiency Diseases in Japanese Prison Camps. By Miss M. W. Grant	91
Moscow Conference on the Theory of Chemical Structure in Organic Chemistry	92
Obituaries:	
Mr. J. McC. Black. By Sir Edward Salisbury, C.B.E., F.R.S.	94
Sir Fred Clarke. By Prof. G. B. Jeffery, F.R.S.	94
News and Views	95
Back Mutation Assay Method in Micro-organisms. By G. W. Grigg	98
Transfer of Hydrogen in Organic Systems. By Prof. R. P. Linstead, C.B.E., F.R.S., Dr. E. A. Braude, P. W. D. Mitchell, K. R. H. Wooldridge and L. M. Jackman	100
Planning and Budgeting of Industrial Research	103
Conference on Dielectrics. By Dr. B. Szigeti	104
Bose Institute, Calcutta: Anniversary Meeting	105
Overseas Food Corporation	106
Letters to the Editors:	
Effect of Weather on Traffic Flow.—J. C. Tanner	107
A New Determination of the Velocity of Electromagnetic Radiation by Microwave Interferometry.—Dr. K. D. Froome	107
Combined Phase-contrast and Interference-contrast Microscopy.—Dr. R. Barer	108
Hydrogen Reduction of Tungsten Trioxide.—M. G. Charlton	109
Infra-Red Studies of Solvent Effects.—N. S. Ham, A. L. G. Rees and A. Walsh	110
Recovery of Radioactive Iodine from Urine.—H. D. Purves	111
A Rapid Routine Method for the Estimation of Nicotine in Tobacco.—B. Ramamoorthy, B. G. Chatterjee, C. Dakshinamurti and K. C. Gulati	112
Effect of Adenosine Triphosphate on the Light-Scattering of Actomyosin Solution.—Yuji Tonomura and Shizuo Watanabe	112
The Cholinesterase of Cholinergic Sweat Glands.—K. Hellmann	113
Isolation of Hyaluronic Acid by means of Buffered Trichloroacetic Acid Solutions.—Dr. W. E. Jancsik and Dr. E. Kaiser	114
Attempt to prepare Anti-Tyrosine Decarboxylase.—Prof. Frank C. Happold and R. Ryden	115
Salicylates and Carbohydrate Metabolism.—Dr. J. Bornstein, B. W. Meade and Dr. M. J. H. Smith	115
Soluble and Available Nitrogen in Manurial Composts.—Delphine A. Hoyle and G. E. G. Mattingly	116
Physiological Effects of the Volatile Products of Respiring Potatoes.—W. G. Burton	117
Bacteriophage Inactivation by Antiphage Serum Diluted in Distilled Water.—N. K. Jerne	117
Presence of Trypanosomes in Bush Babies after Eating Infected Rats.—R. B. Heisch	118
Recombination in *Bact. coli* K 12: Unidirectional Transfer of Genetic Material.—Dr. W. Hayes	118
Pubescent Cottons for Egypt.—Ahmed Afifi	119
Systemic Insecticides and the Mealybug Vectors of Swollen-Shoot Virus of Cacao.—John Nicol	120
The Lotmar – Picken X-Ray Diagram of Dried Muscle.—Dr. C. H. Bamford and W. E. Hanby	120

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UNIVERSITIES AS RESEARCH CENTRES

A FEATURE of the report of the Team which, under the Anglo-American Council on Productivity, visited the United States of America in the spring of 1951 to study the relations between the universities and industry (see *Nature*, January 5, p. 1), is the section dealing with research in American universities and colleges. Quantitatively, little fresh information is included; but, particularly when taken with the paper on applied research in the United States which Dr. H. Vagtborg presented at the International Symposium on the Organization of Scientific and Industrial Research in London last November, the report gives an impressive account of the scale of the American effort compared with that of Great Britain. Research programmes connected with higher education, which could be identified and accounted for in institutional budgets, cost 87 million dollars in 1945–46 and 159 millions in 1947–48; and the latter sum represented 11·4 per cent of the total budget of the institutions, whether publicly or privately controlled. The Productivity Team estimates that American industry contributes to the universities about 25 million dollars per annum in fellowships and grants-in-aid, and, excluding contributions from the universities themselves and from research foundations, 87 million dollars, or £30 million, per annum is received by the universities from Government and from industry for research in science and engineering (excluding nuclear physics). For the United Kingdom the corresponding estimate is not more than £1·5 million, from the Department of Scientific and Industrial Research, industry and the universities themselves.

On these figures, when allowance is made for the population factor but not for relative costs, the United States is spending seven times as much as Great Britain on research in science and engineering in its universities. Furthermore, elsewhere in its report the Productivity Team estimates that 3·5 times as many doctorates in science and 1·9 times as many doctorates in engineering were being awarded in the United States, as compared with the British awards of higher degrees in the same fields of study, before allowing for the population factor. When this is taken into account, there is a slight advantage to the United States in the production of scientific workers at the highest level and a considerable advantage to Britain for engineers. The cost of producing such highly trained men also appears to be very much greater in American than in British universities, although this factor is affected by the aggregate cost of the considerable amount of research carried out in the United States for master's degrees as well as postdoctorate work.

One important consequence of the much larger amount of research in American universities made possible by the very liberal resources for research made available is emphasized by the Team. The graduates trained on this work are mainly absorbed by industry, and it is these people who are capable of appreciating the value of new discoveries and of

directing the application of new ideas to industrial processes. The probable effect of this factor on American productivity leads the Team to urge that in Britain an effort should be made to ensure that an increasing number of graduates in science and engineering pursue postgraduate studies, with or without research, with the view of their occupying positions where their knowledge can influence the climate of opinion in industry.

The Productivity Team recognizes that this can only be done in Britain if increasing support is made available through the medium of the University Grants Committee, the Department of Scientific and Industrial Research and industry itself; the recommendation is one which should be carefully considered by the Government, and especially the Lord President of the Council, in reviewing Government expenditure on scientific and industrial research in the context of the present economic situation. The recommendation is supported, moreover, by figures given by Dr. Vagtborg. Excluding expenditure on the atomic energy programme, he gives expenditure in the United States on basic research in 1947 as 110 million dollars and on applied research and development as 1,050 millions. Of the former figure, 10 million dollars was expended by industry, 35 millions by the universities, 10 millions by research institutes, etc., and 55 millions by Federal departments. The Government contribution on basic research had thus increased from 20 per cent of the total to about 50 per cent in 1947.

The Federal Government contribution to applied research and development is of the same order, totalling 570 million dollars in 1947, as against 440 millions from industry, 30 millions at research institutes and 10 millions at universities. Dr. Vagtborg estimates that for 1951 the expenditure of American industry on research was about 600 million dollars and that development work would bring the total annual expenditure to 2,000 million dollars. He noted further that the recently established National Research Foundation was planned to redress through national funds the loss of endowment income which the universities and research institutions generally are experiencing. The increased dependence of research, and above all of basic research, on Federal support appears to be taken for granted, in spite of the general recognition in American industry that applied research is a paying investment and essential for industrial success and security.

Increasing State support for fundamental research is thus a characteristic of the American scene as elsewhere, and it does not appear from the report of the Productivity Team or from Dr. Vagtborg's paper that such research is any freer in the United States from the risks of curtailment to which it is exposed in most countries at a time of financial stringency; indeed, they may even be greater. Dr. A. J. Waterman, director of the National Science Foundation, remarked at a meeting sponsored by the American Institute of Biological Sciences at Minneapolis on September 10 that support of basic science was in danger of neglect because the public did not yet appear to understand or appreciate the meaning of basic research, and the extent to which scientific progress depends upon the constant flow of ideas from this source.

The Foundation's original budget of 14 million dollars was almost obliterated last August by the Congress Committee on Appropriations, but a Supplementary Appropriations Act later allocated it 3·5 million dollars, thus enabling it to start on its two major operating programmes—support of basic research in the sciences and training of scientific man-power. Nevertheless, a considerable shock must have been given to general confidence in the reliability of government support. Fundamental research can only flourish, as was well emphasized by Sir Ben Lockspeiser at the recent International Symposium on the Organization of Scientific and Industrial Research, in an atmosphere of freedom to which financial instability is as inimical as cramping administration. There may be little risk in Britain even at the present time of such short-sighted and drastic curtailment of expenditure on fundamental research, but we should at least take care that whatever economies are unavoidable are exercised so as to cause the minimum of disturbance and permit the maximum of freedom for long-range projects.

While the quantitative differences between the position of research in American and British universities are striking, the qualitative differences are also important. Control of the large funds derived from external sources involves special problems in some of the American universities: members of the Productivity Team gained the impression that fundamental research prosecuted independently on the initiative of the teaching staffs themselves was small in comparison with that supported by Government or industrial funds. Nevertheless, the quality and character of the work are similar to that being carried out in British universities; but there are three features which should be noted. First, the absence of research associations of the British type leads to a proportion of research at the universities being directed to problems of general interest which might not be considered appropriate in a British university. The wide range of subjects included in the term 'engineering' creates a situation in which, in many universities, applied research tends to dominate. This is assisted by the second feature, which is the extensive provision for carrying out sponsored research. Although frequently 25 per cent and sometimes 50 per cent of the total income of a university is obtained in this way, the danger to academic freedom is not regarded in the United States as serious when the projects are sponsored by industry rather than by the Government. Universities in the United States, as in Britain, do not appear to be keen to engage on sponsored research of a restrictive character, and the Productivity Team formed the opinion that the volume of such work in progress is small.

Nevertheless, it is clear from the report of the Committee on Educational Survey of the Massachusetts Institute of Technology that some concern is felt in the United States as to the possible distortion of the

balance of studies and organization by the scale on which sponsored research in general is undertaken. This can happen particularly when the scale of particular sponsored projects requires the use of teams of experts and of highly expensive apparatus. The reasons which Prof. A. R. J. P. Ubbelohde advanced against placing research of this character in university institutions in Great Britain appear to be no less cogent in American conditions.

The third feature to be noted is the greater extent to which academic staff undertake consulting work for industry in the United States than in Britain. While the practice could be abused, Dr. P. Dunsheath is undoubtedly right in suggesting that there are advantages to both sides in such contacts with extra-mural life. These advantages may be even more important in the higher technological institutions and technical colleges, and the practice might possibly be a factor in facilitating the movement of staff to and from industry which is so important a factor if the teaching of technology is to be kept up to date. Moreover, the increased emoluments available to university staffs in the United States through consulting work counteract to some extent the attraction of high salaries in industry.

Since there is nothing as yet in the United States corresponding to the Department of Scientific and Industrial Research and the research associations in Britain, it may be said that the variety of arrangements for scientific and industrial research in the latter is at least as great in the former, though it must be admitted that the only two British institutions for sponsored research, the Fulmer Institute and the Sondes Place Research Institute, are small compared with their American counterparts such as the Mellon Institute. Mr. E. F. Mactaggart, in a paper on sponsored research at the International Symposium on the Organization of Scientific and Industrial Research, did not suggest that expansion of such research in Great Britain is likely to be on the American scale, partly because of the existence of the research associations. It is possible, of course, that institutes of this type might be even more appropriate than a research association for the location of exceptionally costly equipment, particularly when special staff is required for its economic operation.

DYNAMICS OF CO-OPERATION

The Changing Culture of a Factory

By Dr. Elliott Jaques. Pp. xvii+341. (London: Tavistock Publications, Ltd., in collaboration with Routledge and Kegan Paul, Ltd., 1951.) 28*s*. net.

IN an age when every technical advance emphasizes one man's dependence on another and one group's inter-relation with another, some of the worst chapters in social harmony are being lived out. Strife, in one form or another, is the commonplace setting of our times, and nowhere is this contrast more true than in the spheres of industry. Co-operation is preached unceasingly as the *sine qua non* of productivity and progress; but managers and men alike either seem unable to understand the lessons or are unwilling to put them into practice.

Are there secret formulæ for the process of co-operation? Has the advance of a mechanical civilization dulled human appreciation of co-operative endeavour? No one seems able to answer. We rely very much on 'mechanisms' of co-operation in industry—collective bargaining, federation and union procedures, joint consultative committees, and the like. Is this perhaps the fault, that we have 'mechanized' what ought to remain a human, a social, a living process? Dr. Jaques might not recognize this as one of his conclusions, but the implication of it is clear.

This is a very important book. Its first appeal, because of its title, will be to the industrial population; but others in related walks of life should study it too. Wherever a co-operative effort of people is required, this book has a relevance. A reviewer could not recommend that it should be 'read'; the only appropriate verb is 'studied'. No easy reading-matter here, but stuff of the advanced class, to be pondered.

The first tribute must go to the Glacier Metal Co., near London, for it is a phase of the Company's story that the author has written up. For nearly three years an outside research team has worked with them in the study of aspects of co-operation, and in particular of the barriers and hindrances to co-operation, at worker level, at higher management level, and in the inter-nexus of worker–management relations. The study is akin to that pioneer of industrial relations studies, the Hawthorne investigations of the Western Electric Co. in the United States; the scope is smaller, the setting simpler, the analysis less exacting, but the outcome is no less important, and the contribution to knowledge is in the direct line of succession.

What do we learn? Just as someone once said that all the Hawthorne investigations taught us was "that people matter", so in the Glacier project the main revelation is the inherently human character of co-operation. That such a simple end can be set down is no detraction: recognition of the inherently human character of co-operation is the very first step in its effective attainment. Would that all directors and managers and all trade union officials understood just this simple truth! Any human situation or activity is complex, however much those in positions of authority find it convenient to assume that they are simple. All studies, says Dr. Jaques, "bear witness to the need to approach human problems with due deference to the complexity of the factors at work, and for the unique manner in which these factors operate and interweave in any situation at a given point of time".

The project involved a continuous study of problems of co-operation and communication in this fairly typical engineering factory. Certain main issues formed the backbone of the studies in the sense of providing the centres from which the roles and behaviour of the interacting persons and groups could be observed and analysed. In one case, the issue was that of securing agreement to a change from a payment-by-results basis to that of a fixed rate, looking to the sense of responsibility of the operatives to maintain, and perhaps increase, the level of output. Another problem was that of distributing a lump sum bonus award from the directors, resulting from a good year; this had an unusual by-product in the abolition of 'clocking systems' with a considerable improvement in lost time. The third major issue centred on the

relationships of the managers themselves, beginning in a no less mundane situation than a recurrent dose of late arrival or failure to turn up at a periodic progress meeting. This gave rise to argument on occasion as to functions and roles, and eventually led to the research team being invited to come to help unravel a tangle of conflicting and confused views about rival or respective authorities. Of all the studies portrayed here, this last is likely to be at once the most popular and the most useful among industrial readers : this is the first time that a 'motion picture' of executives in action has been made. The portrayal is clear and frank, and it is not long before these managers (of long-standing acquaintance in the one organization) are prepared to recognize as part of their difficulties "possible sources of hostility and rejection in their own group . . . having denied the existence of any such feelings just one month before and without now being aware that they had denied it".

Throughout the studies the research team made full use of the consultative committee (works council) system in the Glacier factory, and thus a most valuable by-product is an insight into the how's and why's of typical manager–worker consultation. There are gems here for every taste : the enthusiasts can find support for their unswerving and untainted beliefs in consultative committees ; the realistic sceptics can point to the emergence of the view that our trade union arrangements breed leaders who have no skill in co-operation unless it is in the form of 'a fight'. Students of management can find clear evidence of the significance of policy to effective control and of the importance of defined responsibilities. Those familiar with current thought can find the strongest support for the emphasis on the role of the 'social skills' in management.

The depth of treatment in Dr. Jaques's account of the material is too profound to admit of brief summary or review. The book is, indeed, a preliminary treatise on the dynamics of co-operation. In reflexion, one sees what makes co-operation possible and successful, and from the direct view of the cases studied one sees just how co-operation is so often thwarted or hampered, even where its contribution is most essential—hampered not by any malice or perverted intention, but by the very human attitudes of the human beings who are setting out to co-operate. The human process, in other words, becomes entangled in the unrecognized human intricacies of the human situation with which it is unconsciously dealing. In industry or elsewhere, co-operative effort is mostly directed to external objectives—the discussion of a new scheme of wage payment, the modification of the design of a product, the introduction of a new accounting procedure, or many another seemingly factual subject. The Glacier project throws into relief the misleading character of such a description : by the mere act of bringing the persons together to discuss or to deliberate, the complex forces of human emotions are unleashed, and as likely as not the logic of the facts on the agenda will be overpowered by the phantoms of hostility, frustration, power-complex, prejudice from bygone causes, and the other motivations that unconsciously power the behaviour of the human being.

Co-operation is the greatest need of the twentieth century. It is also the field of our greatest ignorance. Gratitude is due to Dr. Jaques and the Glacier Company for this valuable guiding-hand in our blindness.

E. F. L. Brech

LEVELS OF ABSTRACTNESS IN MATHEMATICS

Infinite Matrices and Sequence Spaces

By Dr. Richard G. Cooke. Pp. xiii+347. (London : Macmillan and Co., Ltd., 1950.) 42s. net.

A GIVEN domain of mathematics can usually be treated at several different levels of abstractness. At the lowest level the domain appears to consist of an almost unorganized mass of individual results ; as the level rises groups of results become linked to one another by the unifying influence of abstract concepts until, at the highest level, the whole subject may be considered as a concrete realization of some general type of axiomatically defined structure. This process can seldom be carried through without loss ; at each level there may be results that do not fit into the abstract structure belonging to the next higher level. We usually find, therefore, that we can mark out certain portions of the subject that can be most naturally treated at a given level ; at a lower level the guiding thread is lost or obscured, and at a higher level the results do not fit into the available abstract structures. New developments may, of course, provide more comprehensive abstract structures into which this body of results will fit, and the natural level of treatment may then move up a step or two.

The theory of infinite matrices is to-day generally regarded as belonging to the more abstract theory of linear operators in topological vector spaces, and a considerable portion of its results can be organized in a very natural manner from this point of view. In the book under review Dr. R. G. Cooke has, however, preferred to remain, for the most part, at a lower and more concrete level ; for him, infinite matrices are not realizations of linear operators, but objects with their own laws of combination, analogous to those of finite matrices, and worthy of study in their own right. He indicates the difficulties connected with the fact that the associative law of multiplication fails to hold in general ; later, he discusses more restricted collections of infinite matrices in which the law does hold.

The main body of the book is devoted to matrix methods for the summation of divergent infinite sequences and series. There is a detailed treatment of the group of results associated with the names of Kojima, Schur, Silverman, Toeplitz, Bosanquet, Hahn and Takenaka, consistency problems and problems concerning the efficiency of summation methods are discussed, and results connected with the notion of the 'core' of a divergent sequence are proved. This part of the book forms a valuable supplement to Hardy's comprehensive work on "Divergent Series". The later chapters, on Hilbert space, and on sequence spaces of the Köthe–Toeplitz type, are less successful, since most of the topics treated in them belong naturally to a higher level of abstraction.

The reader will also find numerous results that have not yet been fitted into a more comprehensive abstract structure ; some of these may be useful starting-points for future investigations. Their presence may make up, to some extent, for the omission of a systematic presentation of the part played by more abstract concepts in some parts of the theory ; it is to be hoped that the author will take up this aspect of the subject in his promised second volume.

F. Smithies

LETTERS OF BENJAMIN RUSH

Letters of Benjamin Rush

Edited by L. H. Butterfield. (Memoirs of the American Philosophical Society, Vol. 30.) Vol. 1: 1761–1792. Pp. lxxxvii+624+8 plates. Vol. 2: 1793–1813. Pp. iv+625–1295+7 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1951.) 15 dollars.

IN these two magnificent volumes are amassed a collection of more than 650 letters of a very distinguished physician—Benjamin Rush (1746–1813). To the medical profession he is best known for the important story of his dissensions with his fellow-physicians in the great yellow-fever epidemics which smote the city of Philadelphia in the 1790's. But Rush was a much greater man than this. The scope of his activities was immense; he signed the Declaration of Independence; he was no mean politician and pamphleteer, and was a social reformer, a psychiatrist (even before the full meaning of this term became known), a founder of colleges and churches, a life-long student of his fellow-men and everything connected with them. He was a controversialist of high potency, for he knew how to give hard blows and how to receive them. No longer can we declaim "Who was this Benjamin Rush?", for in this work we have his full portrait expressing himself as a major letter writer in that great age of correspondence. He made good use of his opportunities and was in direct association with not only five presidents of the United States, but also with the leading figures in science and thought on both sides of the Atlantic.

This collection, which has been so meticulously edited by his biographer, L. H. Butterfield, traces Rush's career from his Philadelphia apprenticeship and British studies up to his eminence as an international man of science and philosopher. Whether arguing about purging or blood-letting, or giving matrimonial advice to his daughter, he is always lively and entertaining, often combative and even, at times, indiscreet. The numerous letters addressed to members of his family reveal him as a kind and sympathetic parent.

Previous attempts to collate and publish this series of letters, by Dr. James Mease of Philadelphia in 1816, for which the aid of two ex-presidents, Adams and Jefferson, was solicited, were vetoed by Rush's family, and the same fate attended his autobiography, "Travels through Life", which did not reach print until 1948. The principal reason for the family's reticence appears to have been his quarrel with George Washington. Rush believed in telling his friends something really worth hearing when he wrote to them; but when an enemy intercepted a letter, which happened more than once, he had to pay a heavy penalty for it. However, that experience did not alter his habits. Prudence, he observed, is a "rascally virtue". In his letters written from abroad it is possible to follow the process of his intellectual growth step by step. After his return to America, Rush seldom left Philadelphia; he never took vacations and appeared not to know what the word implied. He belonged to that generation of versatile Americans who contributed to several fields of medicine, but were interested in everything. Apart from his profession, his letters deal with subjects as diverse as psychiatry, forestry, veterinary science, zoology, ventilation of ships, and chemistry. As his writings and lectures spread his fame, so he was called upon for opinions on a variety of subjects: how to train children in the home, the liberation of the Spanish provinces in South America, the origin of prehistoric mounds in Ohio, etc.

British readers will be specially interested in his none too complimentary description of Edinburgh in 1766, his correspondence with John Coakley Lettsom (1783–1810) and his references to Fothergill, Lind, Pringle and other English notables. Less creditable was the famous Cobbett–Rush feud, which lasted several years and ended in a libel suit. Cobbett, who wrote under the pseudonym of "Peter Porcupine" in *Porcupine's Gazette* (1766–1835), was the English writer and agriculturist who twice sojourned in the United States and had a genius for savage journalistic satire without rival in any age. A New York newspaper paragraph observed that Benjamin Rush was a man born to be useful. Cobbett reprinted the paragraph, adding and so is "a *musquito*, a *horse-leech*, a *ferret*, a *pole cat*, a *weazel*, for these are all *bleeders*". After the successful completion of the suit, Cobbett returned to the attack by the issue of a periodical—*Rush Light*—with, as the chief feature, a comic biographical sketch of Rush.

There are many letters to his wife, Julia, who was "prudent and sensible", as indeed, so it appears, is the consort of this faithful biographer.

There are some handsome illustrations, notably the fine portraits of Benjamin Rush (B.R. as he is known) and his wife, Julia Stockton, a very handsome person.

PHILIP MANSON-BAHR

X-RAY ANALYSIS FOR HONOURS STUDENTS

X-Ray Analysis of Crystals

By Prof. J. M. Bijvoet, the late N. H. Kolkmeyer and Prof. Caroline H. Macgillavry. Translated by H. Littman Furth. Pp. xii+304. (London: Butterworths Scientific Publications, Ltd., 1951.) 50*s*.

THE scope of this book is best indicated by the main chapter headings: directions of diffracted X-rays; intensities of diffracted X-rays; X-ray analysis by the trial method; structure determination by Fourier methods; classification and properties of crystal structures; some groups of inorganic compounds; and organic compounds. These chapters (occupying about two hundred pages) are followed by nine appendixes (occupying about seventy pages), which contain descriptions of crystal classes and space groups, mathematical derivations and details of technique omitted from the main text, and an interesting short account of electron and neutron diffraction. The chapters are followed not only by references to papers cited in the text, but also by bibliographies of more advanced books on the subjects of the chapters. The references seem to have been made up to 1947, though there are several from 1948 and one or two from 1949. The authors are very successful in maintaining a uniform level of presentation over the whole range of material. A notable feature is a description of the determination of a structure (mercuric chloride) in complete detail, covering more than ten pages. The reviewer's favourite subject, diffraction by imperfect crystals, receives more generous treatment than is common in elementary books.

The dust cover states that the book provides an introduction for students and a text-book for all

who must acquire a knowledge of the technique and problems of X-ray analysis. Probably the words 'text-book' and 'introduction' should be interchanged; the standard appears very suitable for an honours-degree course. (In a department of physics the lecturer would wish to supplement it with a fuller treatment of the interaction of X-rays and electrons.) The research worker will make use of the bibliography appropriate to his field of specialization.

At the level which the authors have set for themselves there is little to criticize. An explanation of the greater resolution of the α-doublets of cold-worked steel with decreasing wave-length is accepted without comment (p. 58), though probably wrong and certainly questioned. The powder method is capable of greater accuracy than a few parts in ten thousand (p. 51); a few parts in one hundred thousand is routine in metallurgical applications, and a few parts in a million is claimed by some workers.

The book is printed on a heavily loaded glossy paper that gives very good reproduction of the many X-ray photographs illustrated. It is, however, rather brittle, and the folding diagram of the thirty-two crystal classes will probably not last long with hard usage. The translation reads smoothly, though "extinct reflections" may raise a smile. One sentence (p. 34), in which "reflection" and "reflecting plane" both appeared, seemed a complete muddle until it was realized that the former referred to a diffraction maximum and the latter to a mirror plane. The few misprints noted are unlikely to cause any confusion.

A. J. C. Wilson

THE MAGNETIC AMPLIFIER

The Magnetic Amplifier

By J. H. Reyner. Pp. 119+8 plates. (London: Stuart and Richards, 1950.) 15*s*. net.

THE magnetic amplifier, or transductor, is rapidly marking out for itself a field of application within which its characteristics provide definite advantages over the equivalent thermionic amplifier. Mr. J. H. Reyner's book sets out to present the fundamental properties of transductors in simple terms and to provide an introduction to the more advanced literature of the subject. Four of the six chapters constituting the book deal with the basic principles of the transductor, with the characteristics of the practical instrument and with elementary design considerations.

Taken as a whole, the analysis builds up a satisfactory picture of transductor operation, closely related to practical behaviour. The author has, however, set himself the very difficult task of making a detailed analysis of the mechanism of a somewhat complex electromagnetic cycle from a starting point which presupposes relatively little knowledge of electromagnetism. There are, in consequence, a good many gaps which have not been really satisfactorily bridged. It is, for example, doubtful whether the explanation given on p. 30 relating the "inductance" of the transductor to an "effective" slope of the magnetization curve constitutes a convincing argument. A chapter on magnetic materials and a final chapter on some practical applications of transductors complete the book. The former gives a useful practical comparison of the core materials suitable for transductors, and the latter, after summarizing in a clear and straightforward fashion the main advantages and limitations of magnetic amplifiers, gives a brief description of a number of typical transductor applications.

Even allowing for the difficulties arising from the excessively wide range of material covered, the impression remains that the author has taken insufficient pains to minimize ambiguities and loose statements. Notwithstanding these criticisms, however, the book provides a very readable and interesting account of transductor principles and contains much useful practical information.

James Greig

HANDBOOK OF DISEASES OF NORTH AMERICAN PLANTS

Plant Disease Handbook

By Cynthia Westcott. Pp. xii+746. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 56*s*. net.

FOR many years books dealing with plant diseases were few and far between, but since the Second World War quite a number have been published on this branch of scientific study. Most of these modern books have been short and have dealt with the subject in a general way. None of them is suitable as a reference book, and even for people whose livelihood depends on the growing of plants they arouse little more than a fleeting interest in the subject.

The present book is a large one in which a vast amount of information on diseases of plants of North America has been collected. Moreover, Dr. Cynthia Westcott claims that it provides an easy and efficient system by which all kinds of plant diseases can be identified and the appropriate remedial measures ascertained.

There are five chapters; the first three are short and require altogether only forty-odd pages, while the last two between them occupy some 550 pages. There is a glossary of terms, a selected but somewhat limited bibliography, and a good index. Photographs and illustrations are frequent throughout the book and are very good indeed.

The first chapter is the usual review of the subject and is mainly historical. The second, although condensed into twenty pages, is of absorbing interest for it contains most up-to-date information on the chemicals used in modern fungicides and on their formulation into various sprays and dusts which are proving valuable in the control of plant diseases. Chapter 3 is a classification of plant pathogens, bacteria according to Bergey, fungi in the main following that given by Ainsworth and Bisby in their "Dictionary of the Fungi", and viruses according to the scheme recently suggested by F. O. Holmes. The last may be controversial at present, but is considered to be the best system for quick reference in diagnostic work, which is the object of this book.

Chapter 4 groups diseases alphabetically under headings coined from names of common plant troubles—for example, blights, leaf spots and cankers—and under each heading a list of fungi and bacteria causing that kind of trouble. The full Latin name of the pathogen is followed by the name of its host plant or plants, with details of any special symptoms and of necessary control measures. Chapter 5, of about the same size, contains as headings the names in alphabetical order of nearly one thousand host plants, each followed by a list of its known diseases—that is, first the common name of the disease as in Chapter 4,

then the name of the pathogen and lastly its geographical distribution within the United States.

Chapter 5 is thus a reference list for supplying the first clues to the identity of a disease on any particular plant. A person interested, for example, in a leaf-spotting disease first collects in Chapter 5 the names of all the pathogens causing this type of trouble on the selected host plant. He then turns to Chapter 4, where under the heading "Leaf Spots" will be found all the leaf-spotting pathogens with, for any particular host, a detailed description of symptoms and the control measures required.

The system does not take long to understand and does not require the reader to be specially trained in plant pathology. In any event, it does not pretend to provide for accurate diagnoses of any and every disease, but claims to be a useful working guide to assist gardeners, nurserymen, seedsmen and the like in their daily work.

The author is well qualified to write a book of this kind, for she served for many years as plant pathologist on university and experimental station staffs in the United States. She is now doing advisory work in a private capacity as consultant and has written several books on gardening matters. This one claims to be a book of reference for gardeners; but it is much more than that, for it can be of use to scientific workers and should find a place on their bookshelves. The fact that it is written for horticulturists in the United States need not deter plant pathologists in Great Britain from reading it with interest and with profit.

There is no book comparable with it in Britain—there are more comprehensive ones suitable for the academic study of plant pathology, but none which supplies the working horticulturist with this kind of information in such quantity and in such understandable form.

Dr. Westcott has dedicated the book to her old teacher, the late Prof. Whetzel, of Cornell University; and as one who knew him I consider this volume a worthy tribute to his memory. The publisher and printer are to be congratulated on the quality of the paper and the print.

D. E. GREEN

RESEARCH ON MARRIAGE

Patterns of Marriage

A Study of Marriage Relationships in the Urban Working Classes. By Dr. Eliot Slater and Moya Woodside. Pp. 311. (London: Cassell and Co., Ltd., 1951.) 17*s*. 6*d*. net.

WARS often provide opportunities for research that would not otherwise have been undertaken, and this book is an example of this. During the Second World War millions of men were seized from their homes, herded together and subjected to strains and stresses which may have differed in intensity but were of much the same character. The two authors of this book, one an expert in psychological medicine and the other a research psychiatric social worker, took the opportunity of investigating why some of these men broke down under the strain of war service while others managed to tolerate it. To what extent, they asked themselves, is the incidence of a neurosis determined by heredity and to what extent by environment? As their research proceeded, other interesting questions concerning marriage had to be answered. What sort of people do different types of men and women choose as partners? Do neurotics tend to marry neurotics, and, if they do so, are these marriages associated with a high or a low fertility-rate? As a result of this joint war-time inquiry much information of great value to the psychiatrist and to the social worker was obtained. Home conditions and marriage relationships became of paramount importance in this research, so that this book, in which are recorded the results of the inquiry, bears the sub-title of "A Study of Marriage Relationships in the Urban Working Classes".

It is interesting to learn that among the lower classes the chief motive for marrying is not sexual attraction or romantic love, but the desire to acquire a home. "I wanted a wife and was ready to marry anybody"; "it's somewhere to come home to"; "I thought I'd like a home of my own". Such were the answers generally given to the question, "Why did you marry?"; and, as everybody now knows, it was only the fortunate few among these ardent seekers of a home who were destined to find one in the years to come. Small wonder, therefore, that when the hope which originally brought the couple together never materialized, many of them drifted apart.

The conclusions reached by these two research workers are based on the answers returned to their questioning of two hundred married couples. The husbands in these couples were Londoners serving in the Army, Navy or Air Force, who had been admitted to a war-emergency hospital situated not far from the Metropolis. Only Londoners were selected for the inquiry, in order to facilitate subsequent visits to their homes and interviews with their wives. Half these men were patients in the medical or surgical wards of the hospital, and the other half were receiving psychiatric treatment there. This allowed of a comparison being made between psychiatrically normal husbands and those that, psychiatrically speaking, were unsound. It is possible to give only a few of the results of this research. One point that soon became obvious was that like tended to marry like—the intelligent man, the intelligent woman; the neurotic, the neurotic. Sexual attraction played only a minor part in drawing two people together. Among the psychiatrically sound couples 45 per cent claimed to be happily married, 36 per cent considered their marriage satisfactory, 10 per cent unsatisfactory and 9 per cent admitted to being positively unhappy. In the neurotic group happiness or satisfaction in marriage was less frequent. It is clear also from the answers given that children ranked highest in bringing about marital happiness and that other factors, in diminishing order of importance, were as follows: "clerical rating of personality, economic status, intelligence, orgasm adequacy of the female, pre-marital chastity, good looks, stature, rating of personality by test, similarities between husband and wife and test responses". Frequency of intercourse and youth bore no relationship at all to marital happiness.

"Patterns of Marriage" has appeared at a very opportune moment on the very eve of a Royal Commission inquiry into divorce, and it contains information which should be of the very greatest value to members of this Commission. If any criticism has to be made of the book, it is that the valuable information it contains could, by a little more knowledge of the art of writing, have been presented in a much clearer and more interesting way. But that is a criticism that could be made of fifty per cent of technical works by medical authors.

KENNETH WALKER

ULTRA-VIOLET INJURY TO HIGHER PLANTS COUNTERACTED BY VISIBLE LIGHT

By F. C. BAWDEN, F.R.S., and A. KLECZKOWSKI
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KELNER[1,2] showed that the proportion of conidia of *Streptomyces griseus* and of cells of *Bacterium coli* that survived and grew after being irradiated with ultra-violet light was increased by illuminating the cultures with visible light. The phenomenon, which has been called 'photo-reactivation' or 'photo-reversal', has since been observed with several unicellular organisms, and the literature has been reviewed by Kelner[3]. No comparable phenomena seem to have been recorded with fully developed multicellular organisms, but the cleavage-rate of the eggs of a sea urchin (*Arbacia punctulata*), after reduction by ultra-violet irradiation, returns to normal sooner in visible light than in darkness[4].

Visible light also affects the ability of bacteriophage irradiated with ultra-violet light to multiply in and lyse *B. coli*, so that the residual infectivity of irradiated preparations is higher when inoculated bacterial cultures are illuminated than when they are not[5]. This phenomenon is not restricted to bacteria or other unicellular organisms, and we have obtained comparable results with a tobacco necrosis virus in French bean (*Phaseolus vulgaris*, var. Prince) and with tomato bushy stunt virus in *Nicotiana glutinosa*. As with the bacteriophage, no effect is obtained when irradiated preparations of the two plant viruses are exposed to visible light; but when the inoculated leaves are exposed to light, less of these virus preparations seem to have been inactivated than when the leaves are kept dark for the twenty-four hours after inoculation. If the infectivity of irradiated preparations is about 1 per cent of the original when measured on leaves kept dark after inoculation, it is 4–10 per cent when leaves are kept for a few hours in daylight under glass. The effect is obviously not a direct one of light on the virus particles, but operates through some host-cell mechanism that is light-sensitive. There is no evidence to show whether the mechanism reverses some damage to the virus particles or makes conditions in the cell such that the damaged particles can still become established and multiply. Because of this uncertainty, we prefer not to use such terms as 'photo-reactivation'. The phenomenon is not general to all plant viruses, and the residual infectivity of irradiated preparations of tobacco mosaic virus is the same whether the inoculated leaves of *N. glutinosa* are illuminated or not.

The main purpose of this communication, however, is not to describe the various effects obtained by irradiating preparations of different plant viruses, but to record the fact that visible light can prevent lethal effects of ultra-violet radiation on tissues of multicellular organisms. We have worked mainly with the first-formed leaves of *Phaseolus vulgaris*, but have no reason to assume that this species is unique. The plants were raised in a glasshouse and used about two weeks after sowing. The first leaves formed were detached immediately before they were irradiated, and after irradiation they were either floated on water or kept with their petioles in water. The source of ultra-violet light was a low-pressure mercury-vapour discharge lamp made by the Thermal Syndicate, Ltd., fitted with a chromium-plated cylindrical reflector. The intensity of radiation, 99 per cent of which is of wave-length 2536 A., is specified by the makers as 121 micro-watts per sq. cm. at 100 cm. from the lamp. The leaves were laid flat 22 cm. from the lamp and their upper surfaces irradiated. Half the surface of each leaf was shaded from the radiation to act as a control.

Irradiation for two to three minutes had no immediately obvious effects on the leaves, and when the irradiation was succeeded by exposure for some hours to daylight under glass, the irradiated and control parts continued to be indistinguishable macroscopically. By contrast, the irradiated halves of leaves that were kept in the dark for the twenty-four hours after irradiation, although apparently normal after this period, became severely bronzed within the next two days, with a sharp line of demarcation between the irradiated and control parts. Histological examination of sections through the bronzed parts showed that the cells of the upper epidermis were all dead and collapsed. The palisade cells were alive and showed no signs of serious damage, and such leaves could survive for two weeks or more. Examination of sections through the irradiated parts of leaves that were in the light after irradiation showed that almost all the epidermal cells were indistinguishable from those in the control parts, although a few, either isolated individuals or groups of two to five cells, were dead and collapsed. It may be that these cells were inadequately illuminated, but it is equally possible that individual cells vary either in their susceptibility to damage by ultra-violet light or in their ability in visible light to counteract this damage. If the light-sensitive mechanism is itself inactivated by ultra-violet radiation, it is affected only slowly, for leaves irradiated for as long as ten minutes showed no pronounced bronzing when exposed to daylight after irradiation.

When bean leaves were inoculated, either immediately before or immediately after they were irradiated with ultra-violet light, by rubbing their upper surfaces with preparations of the tobacco necrosis virus that produced an average of 100 lesions per half-leaf on unirradiated halves, few or no lesions developed on the irradiated halves, whether the leaves were then kept in the light or dark. Thus, although illuminated cells could prevent the damaging effects of irradiation to themselves, their condition while doing so was such that virus particles could not become established and multiply. When, twenty-four hours after irradiation, irradiated half-leaves were inoculated with the tobacco necrosis virus, their behaviour depended on whether or not they had been exposed to visible light after irradiation with ultra-violet. Those that had, produced almost as many lesions as the control unirradiated half-leaves, whereas those kept in the dark still produced few or none, even though illuminated after inoculation with the virus. Thus, visible light not only prevents the death and collapse of irradiated epidermal cells, but also counteracts initial changes in cell metabolism that prevent infection with viruses.

Taken together with the previous work, our results suggest that the effects of visible light in

counteracting the damaging effects of ultra-violet radiation is a general phenomenon applying to a wide range of cells. The mechanism is obscure: it may be that changes caused to cell components by ultra-violet radiation are reversed in illuminated cells; but it is equally possible that visible light stimulates synthetic mechanisms that produce new components to replace those damaged. As nucleic acid absorbs ultra-violet radiation strongly, and the effects of irradiation interfere with the multiplication of viruses that are nucleoproteins, it is logical to suspect that, when cells are irradiated with ultra-violet light, at least one of the effects is to disturb the nucleoprotein metabolism. Many active systems of cells depend on components that are sensitive to ultra-violet light, and the evolution of organisms capable of surviving in habitats exposed to sunshine may well have depended on the development of some compensating mechanism. The advantages of a mechanism operated by visible light, when cells are never exposed under natural conditions to intense ultra-violet radiation without simultaneously being exposed to visible light of a high intensity, are too obvious to need stressing.

[1] Kelner, A., *Proc. U.S. Nat. Sci. Acad.*, **35**, 73 (1949).
[2] Kelner, A., *J. Bact.*, **58**, 511 (1949).
[3] Kelner, A., *J. Gen. Physiol.*, **34**, 835 (1951).
[4] Blum, H. F., Loos, G. M., Price, J. P., and Robinson, J. C., *Nature*, **164**, 1011 (1949).
[5] Dulbecco, R., *J. Bact.*, **59**, 329 (1950).

DEFICIENCY DISEASES IN JAPANESE PRISON CAMPS

FOR much of our knowledge of human metabolic processes we are indebted to small groups of volunteers who have submitted themselves to restricted and unpalatable diets for a few weeks (less often, months) always knowing that they could withdraw if they wished or if the effects appeared to be too dangerous. Now there has been published* a comprehensive report on the effects of an inadequate, unbalanced and unaccustomed diet, maintained over a period of years, on thousands of men, women and children, prisoners in the hands of the Japanese in Hong Kong and Singapore. There could be no voluntary withdrawal from this 'experiment', and one cannot praise too highly the spirit which led the scientific members of the group not only to alleviate suffering to the best of their ability, but also to record and analyse all those phenomena which might add to the understanding of the mechanisms of malnutrition.

The food available consisted mainly of highly milled rice together with fresh vegetables, small quantities of beans, sugar and cooking oil, and erratic and meagre supplies of meat or fish. This is quite typical of the poor rice-eater's diet at all times, and those who had studied nutrition in the Far East knew the main problems they would have to face—namely, deficiencies of thiamin and the B_2-complex vitamins, possibly complicated by shortages of calcium and proteins as well.

It was, therefore, a primary consideration to devise ways and means of remedying these defects to the greatest possible extent, and great ingenuity was exercised to this end; "all bones, meat and fish, and fish scales, fins and tails, were subjected to prolonged pressure cooking . . . at times as much as 5 to 7 grams [of the resultant paste] could be provided daily for each person". Yeast was cultured, tough and unpalatable leaves were dried and crushed (600 lb. daily in one camp), pine-needles were infused, rice polishings were most carefully utilized, and many attempts were made to make soya beans palatable and digestible, the only satisfactory method proving to be one common in Indonesia, involving inoculation with a fungus. Otherwise, these beans were liable to give rise to much digestive disturbance when used in any quantity, even if first reduced to a fine meal.

Vitamin concentrates were prepared for therapeutic use by crushing and extracting grass and other leaves, by extracting rice polishings, and by the yeast culture already mentioned. An unexpected deficiency in the rations was that of salt, and it became necessary to rely on the use of sea water to make good this lack. Some other ideas which might have proved useful had to be ruled out for lack of fuel, and many that were adopted are as much a tribute to the ingenuity of those men who could make machines out of scrap as to the nutritionist. With all their difficulties, however, these internees succeeded in getting a better balance in their dietary than many a poor Asiatic family does in peace-time. The final paragraph of the report runs as follows: " . . . it is impossible to overestimate the value which a poor diet of the Asiatic type derives from the addition of beans, rice polishings, groundnuts, yeast, and abundant green vegetables. There is no doubt that the comparatively low mortality in the camps . . . was due largely to the production, purchase, and careful utilization of these food materials. Notes on the ways in which they were prepared and used are given . . . and, crude as the methods were, they may suggest ideas for large-scale application to orienta dietaries".

In a diet which, in the civilian camps, all too often provided less than 2,000 Calories per head per day, it usually proved possible to keep the intake of thiamin above the 1-mgm. level. In Singapore the riboflavin intake was often reasonably adequate, but in Hong Kong it was rarely above 0·7 mgm. and frequently fell below this. Intakes of proteins and of calcium were also lower in the Hong Kong camp, averaging 55 gm. and 300 mgm. respectively, against Singapore's 70 gm. and 450 mgm.

There are, of course, many groups of people throughout the world whose food supply only rarely reaches the 2,000-Calorie level; but in these prison camps, with their mainly adult population of comparatively tall people often called upon to perform heavy physical work, energy expenditure could not be reduced sufficiently to prevent a slow, steady destruction of body tissues to meet the deficit which continued long after weights had come down and reserves of fat been used up.

Many different specialists will find material worthy of their detailed consideration in the descriptions of the clinical signs and symptoms which occurred, since it is rare to have available so much information about the diet and environmental conditions of cases presenting similar signs in ordinary life. Some of these signs have already attracted considerable attention, notably the "burning feet syndrome". No less important is the contribution to our knowledge of skin lesions and of changes in the eye brought about by dietary deficiencies. Nevertheless, it is probably the physiologist who has the most to learn

* Medical Research Council: Special Report Series, No. 274. Deficiency Diseases in Japanese Prison Camps. By Dean A. Smith and Michael F. A. Woodruff. (London: H.M. Stationery Office, 1951.) 6s. 6d. net.

from a study of this report; many of the statements commonly found in text-books need to be revised in the light of these experiences—in particular, we need to think again about protein levels and the causes of œdema.

Perhaps the most heartening paragraph in the whole report is the one dealing with rehabilitation. Although it did not prove possible to organize a follow-up of many people, in those who were seen, "weight recovery was very rapid . . . and the only permanent ill-effects detectable were the few irreversible changes in the nervous system, such as spastic paraplegia and optic atrophy. The impression is strong . . . that a year after release there were few ex-internees, except those prevented by age, who were not fit to return to duty in the tropics". One would like an assurance that this recovery persisted, and that there were no later breakdowns; especially one would like to have more information about those who spent four years of their childhood under these appalling conditions. About this group the report is singularly silent.

M. W. Grant

MOSCOW CONFERENCE ON THE THEORY OF CHEMICAL STRUCTURE IN ORGANIC CHEMISTRY*

THE Conference on the Theory of Chemical Structure in Organic Chemistry, called by the Chemical Science Section of the Academy of Sciences of the U.S.S.R., directs attention to the great importance of the questions that have formed the subject of discussion and have attracted the attention of the whole chemical community of our country. More than four hundred chemists, physicists and philosophers of the Academy of Sciences of the U.S.S.R., of the academies of sciences of individual republics, of scientific research institutes, and of the higher educational institutes of the Soviet Union have taken part in the Conference.

The great activity of the participants has clearly shown that the Conference was opportune and necessary and that the questions raised are of real and immediate importance. The chemists, and also physicists, of our country have not given sufficient attention to the struggle for the establishment of the dialectical-materialism world-view in chemical science and allied branches of physics, in theoretical chemistry and, in particular, in organic chemistry, and, as a result, some Soviet chemists have been ensnared by the unsound, idealistic 'theory' of resonance.

The sterile 'theory' of resonance and the blunders of the Soviet scientists who have developed this unsound conception and applied it in their work were subjected to devastating criticism by the participants of the Conference. The Conference has clearly demonstrated the soundness of the theory of the structure of organic compounds due to the great Russian scientist, A. M. Butlerov; this theory lies at the basis of the whole of modern organic chemistry. The Conference pointed out the urgent necessity of further developing Butlerov's materialistic theory of organic compounds and of studying more deeply his works and those of prominent representatives of the famous Butlerov school of organic chemists.

Having considered the report of the Committee of the Chemical Science Section of the Academy of Sciences of the U.S.S.R., the Conference notes that during the period of the Stalin five-year plans there has been created, under the leadership of the Party, of the Government, and of Comrade Stalin personally, a mighty industry of heavy organic synthesis: the first synthetic rubber industry in the world has been created; motor-fuel, synthetic fibre, dye, plastics, and other industries have been created. Recently great progress has been made in the manufacture of complex organic preparations for use in medicine and in the food, textile and other industries. The manufacture has been organized of antibiotics, antimalarials, antituberculosis and other curative preparations, flotation reagents, photosensitizers, insecticides, fungicides, etc.

The Conference notes that the progress of the organo-chemical industry is bound up with the creative development of organic chemistry in our country. Invaluable contributions to organic chemistry have been made by such discoveries as dehydrogenation catalysis by Zelinsky, the dehydroaromatization of paraffins by Kazansky and Moldavsky, isomeric transformations of unsaturated hydrocarbons by Favorsky, the Demyanov, Nametkin, Kizhner and Arbuzov rearrangements, the Lebedev, Rodionov, Nesmeyanov and other reactions, and also by important theoretical generalizations.

The Conference notes that, side by side with these fruitful trends in the theory of chemical structure, there has been a spread of unsound views that are perversions of Butlerov's teaching. In a number of monographs and text-books on inorganic chemistry and the theory of molecular structure, the name of Butlerov, as the creator of structural theory, has been suppressed, and the work of Russian chemists in the development of theoretical organic chemistry has not been assigned its true importance. In recent years there has been a spread in organic chemistry of a concept developed by Anglo-American scientists —the so-called 'theory' of resonance (Pauling) or mesomerism (Ingold). This 'theory', which presents a multistructural view of the molecule, is directly opposed to the basic thesis of Butlerov's theory.

Though unsound in method, physically untenable, and sterile, the concept of resonance or mesomerism has unfortunately found supporters among Soviet scientists (such as the following corresponding members of the Academy of Sciences of the U.S.S.R.: Ya. K. Syrkin, M. E. Dyatkina, M. V. Volkenshteyn, A. I. Kiprianov and others). These scientists, in disseminating the mechanistic and idealistic concept of resonance, tried to cover the invalidity of this concept by references to its alleged basis in quantum mechanics and invoked it to explain all the facts and laws of chemistry. The 'theory' of resonance or mesomerism was taken up in an uncritical fashion also by other Soviet scientists indicated in the report. The spreading of this 'theory' has done harm to Soviet chemistry. It has diverted the efforts of chemists into useless, pseudoscientific directions and created a harmful illusion of explaining many facts and laws, which are in reality not explained at all; it has tried to create an appearance of well-being in the matter of the development of the theory of chemical structure, and, in fact, has held up its further development.

* Resolution adopted by the Conference held on June 14, 1951; translated from *Zhurnal obshchey khimii* (*Journal of General Chemistry of the U.S.S.R.*), **21**, 1729 (September 1951), by Dr. A. E. Stubbs.

The Conference notes that Ya. K. Syrkin, M. E. Dyatkina, M. V. Volkenshteyn, A. I. Kiprianov and others now acknowledge the invalidity and sterility of this 'theory'. The Conference puts on record also that in their addresses in the present discussion Ya. K. Syrkin, M. E. Dyatkina, M. V. Volkenshteyn and A. I. Kiprianov did not give a reasoned criticism of the 'theory' of resonance or mesomerism and a detailed analysis of their serious methodological and ideological errors. The Conference considers that the statements of Ya. K. Syrkin and M. V. Volkenshteyn concerning their ignorance of the works of A. M. Butlerov when compiling monographs on the nature of the chemical bond and of the structure of molecules are unsatisfactory.

One of the main causes that have led to the spreading of the idealistic 'theory' of resonance in Soviet scientific literature has been the insufficient development of scientific criticism among Soviet chemists, who have not promptly seen the unsoundness of this concept and who have not given sufficient attention to the methodology of Soviet chemical science. The decision of the Central Committee of the Communist Party regarding ideological questions has mobilized the attention of the Soviet chemical community to questions of the methodology of science and has helped to reveal errors present in chemistry and to mark out the future path of development of chemical science on the basis of the uniquely correct dialectical-materialistic world-view. The Conference notes the insufficient attention paid by Soviet philosophers to the methodological questions of theoretical chemistry, which, in particular, has been reflected in the fact that the idealistic nature of the concept of resonance was first exposed, not by philosophers, but by chemists.

The Conference approves the main theses of the report presented by the Committee of the Chemical Science Section of the Academy of Sciences of the U.S.S.R., in which the present state of chemical structural theory is analysed, the essentially idealistic nature of the 'theory' of resonance or mesomerism is shown, the errors of certain Soviet scientists are revealed, and the ways for the further development of Butlerov's teaching are marked out.

The Conference considers it necessary to point out also a number of serious defects in the report of the Committee. Thus, it is not shown in the report that the ideological perversions in matters of chemical theory are closely related to the hostile theories in biology and physiology, and that, taken together, these present a united front in the fight of reactionary bourgeois ideology against materialism. In the report the progress of Soviet organic chemistry has not been fully characterized. Insufficient attention has been given to the kinetics of chemical processes, to the influence of the medium, and to the nature of the chemical reagents. Little light is thrown on the chemistry of free radicals and the mechanism of very important intramolecular rearrangements. The report considers only the better-known types of mutual interaction of atoms in the molecule, and these do not at all exhaust the various possibilities in this phenomenon. The terminology of the different type of mutual interaction cannot be regarded as finally established.

The Conference considers that it is essential to intensify work on the development of the theory of organic chemistry by all possible means. The leading line in organic chemistry is that of synthesis, which is associated with the investigation of the structure and properties of organic substances, including natural substances, by the methods of synthetic organic chemistry. It is in chemical synthesis that the link between theory and practice is most clearly manifest. Also, in synthetic work structural theory is being constantly verified and expanded, and its field of application is being widened. Along the line of synthesis, structural theory finds new stimuli to development.

The Conference notes that the most important problem of theoretical organic chemistry is the creative development of Butlerov's teaching and the deepening and widening of his main theses in the light of modern views on the structure of matter. The development of theoretical organic chemistry and, above all, of chemical structural theory must proceed in a state of positive struggle against idealistic and mechanistic theories in chemistry on the basis of the world-view of dialectical materialism.

It is essential to concentrate the attention of Soviet scientists on the deepening and widening of our knowledge of the chemical structure of matter and on the development of the theory of the interactions of atoms in the molecule. It is essential to investigate problems on the dependence of the reactivities of molecules on their structures and on the medium. The study of elementary processes and also of the mechanism and kinetics of reactions is of extreme importance. The study of the dependence of the chemical, physical, physiological and other properties of organic substances on their structures is also of the greatest importance.

In order to solve the problems of the theory of chemical structure it is essential not only to use the chemical methods of investigation that have so brilliantly justified themselves, but also to make more use of the achievements of neighbouring fields of work, particularly those of contemporary physics with all the richness of its experimental and theoretical methods. In connexion with this the Conference notes the withdrawal of the majority of physicists from participation in the struggle for the creation of the foremost theory of chemical science. It is also unsatisfactory that practically none of the leading theoretical physicists have taken part in the work of the present C nference.

The Conference puts on record that physical methods of investigation are not yet sufficiently widespread in organic chemistry and considers it essential that wide use should be made of spectroscopic, electronographic, mass-spectroscopic, and other methods of studying the structure and properties of organic compounds. The problems of the development of the theory of chemical structure demand the working out of the above and of new physical and physicochemical methods of investigation, in their application to the specific problems. The Conference calls on physicists and physical chemists to take an active part in developing these methods.

The Conference notes also the extremely inadequate part taken by theoretical physicists in the development of quantum chemistry. It is essential that Soviet theoretical physicists and mathematicians should take a most active part in the working out of problems of theoretical chemistry and quantum-mechanical calculation. Only by the joint labours of chemists and physicists will the theory of chemical structure be transformed into the quantitative theory that A. M. Butlerov has called for.

It is essential to get more Soviet monographic literature published on questions of theoretical

chemistry. A very important problem is the writing and publishing of new text-books on organic chemistry that correctly portray the present state of chemical science. It is essential to speed up the issue of the works of our classical chemists and, particularly, of the complete works of A. M. Butlerov and of V. V. Markovnikov.

The Conference notes that the Chemical Science Section of the Academy of Sciences of the U.S.S.R., and also scientific institutes and institutes of higher education, must pay more attention to theoretical chemistry and to questions concerning the ideological basis of chemical theories and must intensify their struggle against the infiltration of idealistic 'theories' that are foreign to Soviet science.

The Conference recommends :

(1) The prompt publishing (not later than the end of 1951) of the shorthand report of the Conference.

(2) Wide publicizing of the results of the Conference in scientific journals.

(3) That arrangements should be made to publish discussions on the development of the theory of chemical structure in organic chemistry in the scientific journals—in particular, in the *Journal of General Chemistry*, the size of the journal being increased for this purpose.

(4) The speeding up of the publishing of new text-books on organic chemistry that correctly portray the present state of chemical science, also of Soviet monographs on questions of theoretical chemistry.

(5) That the Chemical Science Section of the Academy of Sciences of the U.S.S.R. should periodically call conferences on the most important questions of organic chemistry and should invite specialists from allied sciences (physicists, philosophers, biologists, etc.) to attend.

The Conference calls on chemists, and also on scientists working in allied fields of physics, to take up the further creative development of A. M. Butlerov's theory of chemical structure on the basis of dialectical materialism, guided by the great works of I. V. Stalin and by his directions concerning the role and significance of progressive science in the evolution of society and of the role and significance of criticism in the evolution of science. The Conference calls on Soviet chemists to take all possible steps for the further advancement of theoretical chemistry and for the wide utilization of the results of scientific work for the national economy.

Under the guidance of the party of Lenin and Stalin, Soviet chemists will honourably carry out the directions of the great leader of the workers, the scientific genius, Iosif Vissarionovich Stalin.

OBITUARIES

Mr. J. McC. Black

It is with regret that we learn of the death in Adelaide on December 3 of John McConnell Black, the doyen of Australian botany, in his ninety-sixth year. Born in Scotland on April 28, 1855, at Wigton, Black was educated at Wigton Grammar School, the Edinburgh Academy, Taunton College School, where other devotees of natural science have been trained, and afterwards at Dresden. At the outset of his career he joined the staff of the British Linen Company's Bank; but at the age of twenty-two he migrated to South Australia, where, in the Baroota district, he spent five years farming. For the next twenty years he served as a reporter on the staff of the *Register and Advertiser* of Adelaide. When, in 1902, he retired from Press work, he devoted himself to the study of the local flora, a subject which he made peculiarly his own. In 1909 there appeared his "Naturalised Flora of South Australia", which included descriptions of 368 species. Thirteen years later, when Black had already attained the age at which most men are thinking of retirement, there appeared the first part of what has become the standard flora of South Australia. This contained generic and specific descriptions of all the then known indigenous species and established aliens among the vascular plants. Two years later, namely, in 1924, the second part was published, the third appeared in 1926 and the entire work of seven hundred pages was completed in 1929, embodying clear and adequate descriptions of nearly 2,500 species. In appreciation of this outstanding achievement, largely based on his own original work, Black received a number of recognitions. He was awarded the Verco Medal of the Royal Society of South Australia and became president of that body in 1933. In the same year Black was elected an associate of the Linnean Society of London, and the Australian and New Zealand Association for the Advancement of Science awarded him the Mueller Memorial Medal. He thus joined the eminent company of Douglas Mawson, Leonard Cockayne and Wood Jones, all fellows of the Royal Society of London who were his immediate predecessors as recipients of the Medal.

When I visited Mr. Black in Adelaide he was, at the age of ninety-four, remarkably active both in mind and body and might easily have passed for a contemporary of a man twenty-five years his junior. Then, and almost to the time of his death, Black was working on the second edition of his flora. Parts 1 and 2 have already appeared, and on the very day before Black died he had completed the revision of the manuscript for Part 3 up to the Plumbaginaceæ.

Thus botanical science loses one more of those gifted and distinguished amateurs who have often done so much to enlarge our knowledge of the floras and faunas of the world's surface.

E. J. Salisbury

Sir Fred Clarke

Sir Fred Clarke, who died suddenly at his home in London on January 6, played a notable part in the promotion of higher studies in education in Great Britain. Born and bred in Oxfordshire, he was professor of education for five years in Southampton, eighteen years in Cape Town, and five years in McGill, before he became, in 1936, professor and director of the Institute of Education in London. It is not surprising that an outstanding feature of his tenure of that office was the development of strong ties between educationists in the older Dominions and the Institute. Under his leadership the Institute became a centre for the exchange of educational ideas and experience for the whole Commonwealth.

He took an active part in many important educational movements during the war period. He was an active member of the National Union of Teachers. As a member of the McNair Committee he was a strong advocate of the participation of the universities in teacher training. It was largely as the result of his inspiration that the National Foundation for Educational Research came into being. He was the first

chairman of the Central Advisory Council for Education (England), the report of which on "School and Life" bears many marks of his philosophy of education.

In the course of his last public speech he said that he had lived to see most of his hopes realized. Certainly the results of his constructive thinking were many and widespread.

Sir Fred Clarke's educational philosophy was based on a deep faith in the English tradition. His special gift was that he was able to interpret that tradition with pride and with humility. He saw in it the real ties which could bind the Commonwealth together. He believed that education was an instrument for its sustaining and development. He held that it was the character of a people which determined its destiny, and that the material and economic circumstances of a nation were but symptoms of things lying deeper within its life. As education was in his view primarily concerned with laying the foundations of character, it was to him all-important.

He was beloved by all who worked with him or came within the reach of his inspiration. Wherever he went he had a word of encouragement and a touch of good humour. He was a merry man, and his twinkling eye and his pipe which never could contain its contents will be held in affectionate remembrance.

G. B. JEFFERY

NEWS and VIEWS

Zoology in the University of Lucknow: Prof. K. N. Bahl

PROF. K. N. BAHL retired from the chair of zoology in the University of Lucknow in September last, and was reappointed as a research professor; he has now been appointed vice-chancellor of Patna University. Prof. Bahl's retirement from active zoological research and teaching in the University of Lucknow, which he has served for thirty years with great distinction, is an event of special importance to Indian zoology. Prof. Bahl was educated at the Government College, Lahore, and the University of the Punjab, from which he received the degree of D.Sc. for his discovery of a new type of nephridian system, which he termed the 'enteronephric', in the common Indian earthworm. After a period at Oxford he returned to India and was appointed reader and head of the Zoology Department at the University of Lucknow in 1921, becoming professor in 1923. In 1938 he was awarded the D.Sc. by the University of Oxford. At Lucknow Prof. Bahl quickly earned a reputation by his inspiring teaching and his brilliant investigations. His zoological contributions fall into two categories. First may be mentioned his personal researches, especially on the morphology and physiology of the earthworms and other invertebrates. The elucidation of the structure, development and physiological function of the excretory system of earthworms may be regarded as his most important contribution. His tastes are, however, catholic, and he has worked with great skill on the details of pairing and egg-laying in the snail *Pila* and on the structure of the skull of the reptile *Varanus*. The second part of his contribution lies in his being the founder and editor of the now famous series, "Indian Zoological Memoirs", on Indian animal types, in which eight volumes, some of them running into four editions, have so far been published. The memoirs constitute landmarks in the history of Indian zoology, as they provide the basis of graduate and postgraduate teaching of morphological zoology in India in so far as the invertebrates are concerned. Many honours have come to Prof. Bahl. He was president in 1950 of the Zoological Society of India, of which he is a foundation fellow and honorary fellow. He is also a foundation fellow of the National Institute of Sciences of India. In recent years he has played an increasingly prominent part in the educational field, and during 1948–49 he served as a member of the University Commission of the Government of India.

American Association: Twenty-fourth Newcomb Cleveland Prize

THE twenty-fourth award by the American Association for the Advancement of Science of the Thousand Dollar Prize, now to be known as the Newcomb Cleveland Prize, was made at the Philadelphia meeting to Dr. J. Laurence Kulp, assistant professor of geochemistry in Columbia University, New York, for his paper entitled "Natural Radiocarbon Measurements". The award is made annually for a noteworthy paper presented as part of a regular programme of the annual meeting of the Association and representing an outstanding contribution to science. The generous, and previously anonymous, donor of this award, administered by the Association, was the late Newcomb Cleveland, of New York. He became a life member of the Association in 1923 and was the donor of this award beginning that year. With a fund of 25,000 dollars left as his bequest, the Association is to continue to make this award, but it will now be known as the Newcomb Cleveland Prize. It was always the wish of Mr. Cleveland that this prize should be awarded each year to one of the younger scientific workers and that it should not be divided among two or more, whether working independently or in collaboration. The prize is awarded upon the recommendation of a special prize committee.

East Malling Research Station: Mr. C. T. Royle

MR. C. T. ROYLE, secretary of the East Malling Research Station, retired on December 31, after eighteen years service. He took up his post in October 1933; since then the experimental farm has doubled in size and the research staff quadrupled. In this connexion one of his most important tasks was the purchase of the Bradbourne Estate and its conversion to form the administrative headquarters of the Station. The efficient running of this large, complex Station and the cordial relations that exist between fruit-growers and the staff at East Malling, exemplified by the flourishing East Malling Research Station Association, owe much to Mr. Royle. He is succeeded by Mr. T. R. Littlehales, who has been working with him as his assistant since January 1950.

National Institute of Sciences of India

IN his presidential address at the annual general meeting of the National Institute of Sciences of India on October 5, Dr. S. L. Hora referred to the

establishment in 1951 of a separate Ministry in the Union Government for Natural Resources and Scientific Research, with Sir S. S. Bhatnagar as its first secretary. Imperial Chemical Industries (India), Ltd., has given Rs. 336,000 for the award of research fellowships in physics, chemistry and biology for the next five years. Dr. Hora also directed attention to the fact that the Institute was meeting in its own building in Delhi, a building not yet complete, but one projected to house the Institute after it had enjoyed the hospitality of the University of Delhi since its transference to Delhi from Calcutta in 1945.

State Economic Areas in the United States

To meet an increasing desire for more information about geographical areas of specialization, the United States Bureau of the Census has adopted new functional groupings which have been named 'State Economic Areas'. These new groupings, which are a feature of the 1950 Censuses of Agriculture, Population and Housing, are fully described by Donald J. Bogue in a publication of the Bureau of the Census, United States Department of Commerce, entitled "State Economic Areas. A Description of the Procedure used in making a Functional Grouping of the Counties of the United States" (pp. 96; Washington, D.C.: Govt. Printing Office, 1951; 1 dollar). A useful outline map is included which sets out the boundaries of the 501 State Economic Areas which have been delimited; each area on this map being marked by a symbol which will be used in identifying all statistics for that area in Census publications. The areas are relatively homogeneous subdivisions of States which show significant characteristics distinguishing them from adjoining areas. In determining them, demographic, climatic, physiographical and cultural factors have been taken into account as well as industrial and commercial activities. The name, State Economic Areas, has been adopted in order to convey the implication that each State has been divided into its principal units and that within each unit a distinctive economy prevails; the term economy being used in its broadest sense as the total adjustment which the population of an area has made to a particular combination of natural resources and other environmental factors.

Anthropological Studies of the Gusii Tribe of East Africa

Dr. Philip Mayer, who acted as Kenya Government sociologist during the period 1946–50, is the author of "Two Studies in Applied Anthropology in Kenya" (Colonial Research Studies No. 3. Pp. 33; London: H.M.S.O., 1951; 2*s*. 6*d*. net), which deal with some investigations in primitive economics made during this period. The first is an examination of an indigenous co-operative association for farm work, and the second describes various measures adopted by the local African councils to control inflation of bride wealth. Both refer to the Gusii tribe. The two studies are interesting in illustrating how a 'chiefless' society which was notoriously unable to unite for political purposes is able to combine for economic needs; and they suggest that in the introduction of rural development schemes which are primarily economic rather than political in their objectives, the local-government administration would do well to discover and to use existing economic groupings rather than seek to work through the existing local-government machinery of chiefs and native councils. District officers in other areas of Central and East Africa should find these two reports both interesting and useful. Mr. A. Phillips, reader in Colonial law in the London School of Economics and Political Science, contributes a brief introduction.

Radio Stars in the Northern Hemisphere

A paper by M. Ryle, F. G. Smith and B. Elsmore (*Mon. Not. Roy. Astro. Soc.*, **110**, 6; 1950), entitled "A Preliminary Survey of the Radio Stars in the Northern Hemisphere", gives the results of the observations made at Cambridge since May 1948 of fifty radio stars in the northern hemisphere. The survey was made on a wave-length of 3·7 m., and the stars ranged between magnitudes 3·9 and −3·4. A short description is given of the spaced-aerial interferometer with an aperture of 110 λ and of the method employed for its use. The accuracy of determination of the position of a radio star depends on the intensity of the source, and the two most intense ones, in the constellations of Cygnus and Cassiopeia, can be located with an accuracy of about 3′ of arc, but most of them cannot be located with an accuracy of more than a degree of arc. Table 1 of the paper gives the co-ordinates, intensities and apparent magnitudes of the fifty stars investigated; the zero of the magnitude scale was arbitrarily chosen as corresponding to an intensity of 10^{-23} W. m.$^{-2}$ (c./s.)$^{-1}$. There exists the formidable problem of distinguishing between the radiation from an individual source and the general background radiation from the galaxy, but Ryle has shown that the presence of a large number of radio stars distributed throughout the galaxy would account for the general background radiation from it. At present it is possible to resolve only those sources that are nearest, owing to the poor resolving-power of the apparatus. The radio stars discovered have so far shown no detectable concentration in the galactic plane, and from this it is concluded that they must be outside the galaxy, or, if they are within it, they must be at distances small compared with the dimensions of the galaxy. It is believed that most radio stars are situated within the galaxy with an average population comparable with that of visual stars. Attempts to identify radio stars with various types of diffuse body within the galaxy and with planetary nebulæ and star clusters have not been successful, and at present the only conclusion is that they are a hitherto unobserved type of diffuse body, in which a very intense radiation is associated with a very small visual intensity.

Measurement in Medicine

In an introductory chapter to "Measurement in Medicine" (*Brit. Med. Bull.*, **7**, No. 4, Part 1; 1951), Sir Henry Dale refers to "the recent and most welcome weakening of the attitude of critical aloofness which formerly prevailed between the experimental research workers in the laboratories and the clinical observers in the hospital wards". There is, he says, in the articles of this publication plentiful evidence of this new sense of sharing in the advance of medical knowledge. The subject headings of these articles (and authors) are as follows: the history of the quantitative approach in medicine (Dr. E. Ashworth Underwood); the measurement of normality (Dr. P. L. McKinlay); the clinical trial (Prof. A. Bradford Hill); biological standards and the measurement of therapeutic activity (Dr. A. A. Miles); biological assay (Dr. A. Finney); co mposition of the body

(Prof. R. A. McCance and Dr. E. M. Widdowson); the quantitative approach to hospital biochemistry (Dr. I. D. P. Wootton, Prof. E. J. King and Dr. J. Maclean Smith); measurement of public health (Dr. Percy Stocks); measurements of the growth and form of the British people (Dr. G. M. Morant); and clinical evaluation of chemotherapy in tuberculosis (Dr. Marc Daniels).

Geological Survey of the Scottish Border

In order to encourage research in geological fieldwork, leading to a Ph.D. degree, the Shell Petroleum Co., Ltd., has in recent years been offering a number of postgraduate studentships tenable at universities in Great Britain (see *Nature*, **166**, 1099; 1950). The only conditions of these awards are first that the student must change the university of his graduation, and second that the subject of his study must in some way be related to the conditions, sedimentary and tectonic, of oil occurrence. One of the areas in Great Britain where conditions are eminently suitable for training is the Border region of Lower Carboniferous rocks between Carlisle and Berwick. There are sedimentary and tectonic conditions of great interest, and much of the ground has not been surveyed since the first geological mapping of the 1860's. In this area there are already five research workers, holding Shell studentships at the Universities of Leeds, Glasgow and Edinburgh, and at King's College, Newcastle. The Department of Geology at King's College, Newcastle, has been engaged in mapping the Border for some years, and research on the limestones of Eskdale is also being done in the University of Nottingham. All the geologists working on this project are in touch with the regional offices of H.M. Geological Survey; and it is hoped that the results of this co-operative research may, when it is complete, make a substantial contribution to the mapping of this region.

Physical Society's Annual Exhibition

The thirty-sixth annual exhibition of Scientific Instruments and Apparatus arranged by the Physical Society will be held during April 3–8, excluding Sunday, in the Royal College of Science Main Building, Imperial Institute Road, and in the Huxley Building, Exhibition Road, London. All tickets will be valid for entry into both buildings. The first day will be reserved for members of the Society and Press only. Discourses will be delivered by eminent men of science on April 4 and 7, and the prize-winning entries of the Society's annual Craftsmanship and Draughtsmanship Competition will be on show. A handbook of the Exhibition, containing descriptions of exhibits, will be available early in March (price 7*s*. 3*d*., including postage) from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Conference on Phase Changes

The Société de Chimie Physique, in conjunction with the Thermodynamics Commission of the International Union of Physics, is holding a meeting in Paris during June 3–7 on "Phase Changes". The meeting will be divided into ten sessions as follows: general principles, condensation, critical phenomena, fusion, theories of co-operative phenomena in solids, ferromagnetism and lambda-points, polymorphism and rotational transition, solutions, transition in amorphous substances, and transitions in superficial phases. Each session will open with a general review lasting about 30–45 minutes, followed by papers, each 10–15 minutes in duration, and then general discussion. The texts of papers (the titles of which should already have been submitted) must be sent in before March 1. All communications should be addressed to Prof. G. Emschwiller, École Supérieure de Physique et de Chimie, 10 rue Vauquelin, Paris 5e.

Announcements

Dr. John Jackson, recently His Majesty's Astronomer at the Cape, has been awarded the Gold Medal of the Royal Astronomical Society for his work on stellar parallaxes and his contributions to the general problems of star positions and proper motions.

Prof. Henri Humbert, professor of phanerogamic botany in the National Museum of Natural History, Paris, has been elected a member of the Botany Section of the Paris Academy of Sciences in succession to the late M. Joseph Magrou.

Mr. D. B. Waters has been appointed officer-in-charge of the Scottish branch of the Road Research Laboratory (Department of Scientific and Industrial Research), in succession to Dr. R. S. Millard. Mr. Waters was formerly in the bituminous materials section of the Laboratory. For the past year he has been with the United Kingdom Scientific Mission in Washington, D.C., studying American methods in civil engineering. Dr. Millard is now head of the bituminous section of the Materials Division of the Laboratory.

The Warren Research Fund Committee of the Royal Society is initiating a programme of research on low-pressure gaseous discharge, and for this purpose has appointed the following research workers for a period of three years: Mr. L. W. Kerr, to work at the University of Birmingham; Mr. C. G. Morgan, to work at University College, Swansea; Dr. E. J. Smith, to work at University College, London. A grant has also been made to Mr. J. M. Somerville, of New England University College, Armidale, Australia, to enable him to work for one year at University College, Swansea.

The Department of Scientific and Industrial Research has recently made available to Aslib (formerly the Association of Special Libraries and Information Bureaux) a special grant to establish a consultant service in the special library and information field. This service, drawing upon the existing resources of Aslib, and backed by new research into information techniques, is now available to advise those who are considering the establishment of special libraries and information services in industry and research establishments, and to assist the development of existing services. Details regarding this Service and other facilities provided by Aslib can be obtained from the Director, Aslib, 4 Palace Gate, London, W.8.

Errata. In the article entitled "Metal Economics" published in *Nature* of January 5, p. 12, the total deficit of copper should be 259,000 tons instead of 295,000 tons as printed. Prof. W. R. Jones is wrongly described as from University College, Cardiff; he is emeritus professor of mining geology in the Imperial College of Science and Technology.

BACK MUTATION ASSAY METHOD IN MICRO-ORGANISMS

By G. W. GRIGG
Botany School, Cambridge

EXPOSURE to X-ray and ultra-violet light irradiation is claimed[1,2] to increase the back mutation-rate of micro-organisms very substantially. The technique evolved has been used as an assay for the mutagenic activity of various radiations and chemicals[3–4]. The production of reverse mutations by irradiation must be regarded as highly critical evidence of the qualitative similarity of mutations induced by irradiation to those which occur spontaneously. However, the evidence for the induction of reverse mutations is questionable, even, as will be shown, in micro-organisms.

Apart from micro-organisms, most work on the induction of back mutations by radiations has been with *Drosophila* and maize. In *Drosophila*, X-rays have been reported to induce reversions of several different mutant genes, including some which arose following irradiation[6–7]. However, in the past decade evidence has accumulated to suggest that X-irradiation will not induce reverse mutations in *Drosophila*. Lefevre[8] has reported an extensive series of experiments upon germinal reversion of the genes which had been studied by Johnson and Winchester[7], namely, yellow, white, singed-3 and forked, and also upon somatic reversion of white. No reversions were observed, although the scale of the experiments was such that a large number would have been expected if Johnson and Winchester's data were reliable. Demerec[9], Kaufmann[10] and others have similarly failed to confirm the earlier work. It has been suggested that the appearance of wild-type alleles after irradiation was due to contamination of the treated stocks or to the production of suppressor mutations at another locus and not to radiation-induced reverse gene mutations[8]. Stadler[11] found no induced back mutations in maize, and he concluded that ionizing radiation produced only gene loss. In sum, the most reliable evidence from *Drosophila* and maize shows that radiation-produced mutants are not qualitatively similar to spontaneous ones.

The reports that back mutations have been induced in micro-organisms, such as *Neurospora*, by X- and ultra-violet-radiation are in apparent contradiction with this conclusion. Thus, either genes in *Neurospora* are different from those of *Drosophila* and maize in their reaction to irradiation, or the experiments are fallacious. The present work is a test of the experimental technique.

The back mutation method generally used consists of the plating out of large numbers of treated cells of a biochemically deficient mutant in minimal medium. It is presumed that any cell containing a wild-type nucleus will produce a colony. The difference in the number of colonies produced in the treatment plates and in the control plates (which contain a similar concentration of mutant cells) is assumed to be due to the mutagenic activity of the treatment.

Fig. 1. Inhibition of wild-type microconidia by *W40A*. All plates contain the same number of wild-type conidia in sorbose minimal medium. Number of *W40A* conidia added in (*a*) none; in (*b*) 3×10^8; in (*c*) 3×10^6; and in (*d*) 3×10^7

Mutant strain used	Wild-type conidia used	Number of viable mutant conidia per plate	% inhibition of wild type
(*a*) Macroconidial			
37401 (inos.)	70007 (macroconidial)	c. 4×10^7	100
	" "	4×10^6	0
W40A (purple aden.)	" "	4×10^7	100
	" "	2×10^7	0
W40.1	*S18H.23* (microconidial)	3×10^6	100
		3×10^5	75
(*b*) Microconidial			
9a.91 (purple aden.)	" "	4×10^7	100
	" "	1×10^7	50
	" "	1×10^6	0
39401–55 (tryp.-nicot.)	" "	8×10^7	100
	" "	8×10^6	70
	" "	8×10^5	0
CE51 (meth.)	" "	12×10^7	100
	" "	4×10^7	75
	" "	4×10^6	0
CE9 (aden.)	" "	18×10^7	100
	" "	6×10^7	43
	" "	6×10^6	0
CE42 (leuc.)	" "	5×10^7	100
S10H-26 (histid.)	" "	8×10^7	100
	" "	2×10^7	30
	" "	1×10^7	0

The method assumes that wild-type cells will grow irrespective of the presence of the mutant ones which cannot grow on the minimal medium. This absence of inhibition appears never to have been tested, as it can be very readily by reconstruction experiments in which a known number of viable wild-type cells is added to a suspension of cells of the mutant strain used containing a known concentration of viable cells and the mixture plated out on minimal medium.

Such reconstruction experiments have been made with several biochemical mutant strains of *Neurospora crassa* as follows. Conidia of mutant and wild-type stocks were washed off slope cultures with sterile distilled water, filtered through cotton wool to remove mycelial fragments and centrifuged. The supernatant was replaced with sterile water, the suspension again centrifuged and the washed conidia resuspended in sterile water. All suspensions and subsequent dilu-

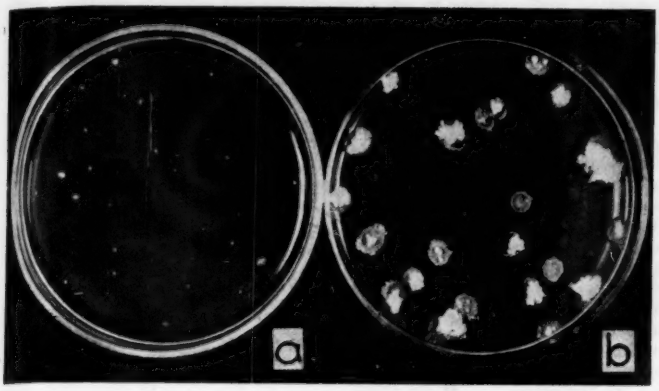

Fig. 2. Effect of a sub-inhibiting dose of *W40A* on the growth of 70007 conidia. Both plates contain an equal number of 70007 conidia. (*a*) has 2×10^3 *W40A* conidia added and (*b*) has none

tions were made in screw-capped bottles and immediately before use vigorously shaken to break up clusters. The concentration of wild-type cells was determined with a hæmocytometer, and the suspension was diluted to contain about 30–50 viable conidia per ml. One ml. of this dilute wild-type suspension and one ml. of a suspension of washed mutant conidia were mixed together in each of a number of experimental platings using 10 ml. of minimal sorbose medium (containing 0·2 per cent sucrose and 0·4 per cent sorbose) per petri dish. As controls, similar 1-ml. aliquots of the wild-type suspension and of the mutant suspension were plated out separately in minimal medium and incubated at 25° C.

Conidia from all mutant strains tested had an inhibitory effect on the growth of wild-type conidia (see table). The conidial concentrations of a particular mutant strain necessary to inhibit a microconidial wild-type and a macroconidial wild-type strain were quite different. The microconidia are uninucleate, while the macroconidia have an average of about three nuclei each.

The macroconidial purple adenineless strain *W40A* and the inositolless strain 37401, used in experiments on mutagens[1,3,4], were the most powerful inhibitors of wild-type conidia of all those tested. It was found that all wild-type microconidia added were completely inhibited by the presence of 3×10^6 *W40A* conidia, and a 75 per cent inhibition resulted when 3×10^5 *W40A* conidia were present (Fig. 1). The concentration of *W40A* conidia necessary to inhibit wild-type macroconidia totally was much greater. Thus 4×10^7 conidia per plate were necessary to inhibit the growth of macroconidia of the adenine independent strain 70007 totally when these were added. However, 2×10^7 conidia per plate scarcely reduced the numbers of colonies growing; but these colonies were all extremely minute as compared with the control colonies grown on minimal medium which did not contain *W40A* conidia (Fig. 2). Similar results were obtained with 37401. *W40A* conidia, killed by ultra-violet irradiation, when added in high concentration, about 5×10^7 per plate, did not inhibit wild-type microconidia but instead seemed to stimulate their growth.

The inhibitory effects of different microconidial mutant strains tested appear to differ to some extent. Thus 8×10^7 conidia per plate of strain 39401–55 (tryptophane–nicotinicless) totally inhibited wild-type microconidia whereas 12×10^7 conidia per plate of *CE42* (leucineless) and 18×10^7 conidia per plate of *CE9* (adenineless) were needed to inhibit the wild-type conidia. One hundred per cent of the viable wild-type microconidia added were inhibited by 4×10^7 conidia of the purple adenineless mutant 9*a*.91. It is of interest to note that 9*a*.91 is an allele of the biochemical mutant in *W40A*. The concentration of the microconidia of 9*a*.91 necessary to inhibit wild-type microconidia is the same as the concentration of macroconidia of *W40A* necessary to inhibit wild-type macroconidia, namely, 4×10^7 conidia per plate.

It is apparent that since added wild-type conidia are inhibited by various concentrations of the mutant strains tested, any wild-type conidia naturally present in the mutant strain could not grow if there was an inhibiting dose of mutant conidia. Thus platings of large numbers of mutant cells are useless as controls, the absence of growth not being evidence of the absence of wild-type conidia and nuclei.

There is the possibility that the back mutations supposedly due to irradiation or chemical treatments are, in fact, already present in the untreated controls but are inhibited by the large number of the other conidia present. Many mutagens are rather toxic, and they could appear to produce back mutants

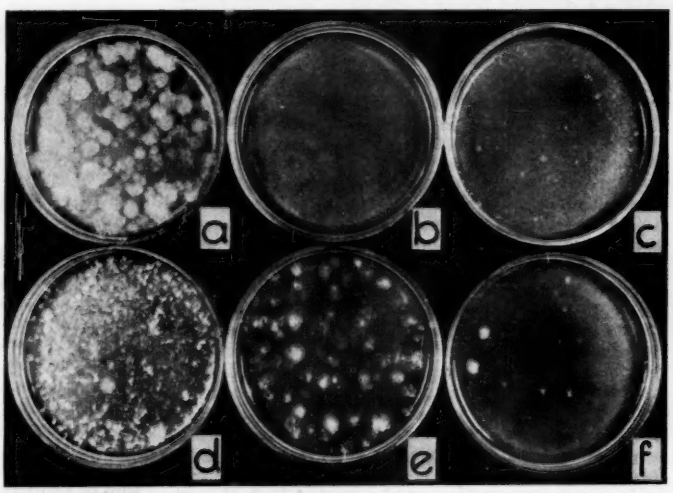

Fig. 3. Comparison of the frequency of wild-type colonies in platings of ultra-violet irradiated conidia (*a*) with frequencies in platings of unirradiated conidia at various dilutions (*b–f*). Numbers of *CE42* conidia per plate are in (*a*) 5×10^5, including the 95 per cent killed by the irradiation, in (*b*) 5×10^5, in (*c*) 5×10^4, in (*d*) 5×10^3, in (*e*) 5×10^2 and in (*f*) 5×10^1

simply by killing off proportions of the inhibiting mutant cells or nuclei, or by relieving the inhibition in some other way.

If there were a floating population of wild-type cells present in the mutant population, then dilution of a conidial suspension of a mutant to a concentration less than the inhibitory one might allow wild-type colonies to appear. This type of dilution experiment has so far been done with three strains, namely, the macroconidial *W40A* (purple adenineless) and the microconidial *CE42* (leucineless) and *9a.91* (purple adenineless). Neither of the microconidial strains showed any wild-type colonies when plated out in high concentration; but large numbers of wild-type colonies appeared at lower concentrations. Radiation experiments showed that approximately all the wild-type colonies which arose when the irradiated conidia were plated out could be accounted for by the wild-type conidia present in the unirradiated suspension (Fig. 3). Colony-counts in dilution experiments demonstrated that the stocks of *CE42* and *9a.91*, although showing no growth of colonies when plated out on minimal medium at the concentrations customarily employed in back mutation experiments, that is, about 10^7–10^8 per plate, actually contained between 0·02 and 0·2 per cent of wild-type nuclei.

As mentioned previously the *W40A* strain contains a biochemical mutant gene (purple adenineless) allelic to that in *9a.91*, and it is possible that spontaneous back mutations of these genes would occur with equal frequency in both strains. However, minimal platings of *W40A* conidia at a concentration 10^8 per plate, which is insufficient to cause appreciable inhibition of uninucleate wild-type conidia, produced no wild-type colonies. Thus, if there were numbers of wild-type nuclei present in this strain, an intraconidial inhibition must also be postulated if mutagenic action is rejected, and the so-called mutagens would act by eliminating inhibiting *W40A* nuclei in the conidia. Intracellular inhibition is suggested by Ryan's observations on leucineless[12]. The occasional wild-type colonies appearing when a dense suspension of *W40A* conidia is plated out may come from a macroconidium containing more than one wild-type nucleus, the number of *W40A* conidia present being more than twenty times that necessary to inhibit uninucleate wild-type conidia completely. If such a macroconidium containing several wild-type nuclei arose as a result of several independent back mutations, indicating a high mutation-rate, a large number of conidia would be expected to contain a single wild-type nucleus. If, however, a wild-type nucleus appearing in the culture could multiply, its descendants would tend to be distributed non-randomly, and macroconidia containing several of these wild-type nuclei would occasionally be formed. Now, if the colonies appearing in *W40A* do originate from wild-type macroconidia, it is probable that many other macroconidia, which behaved as mutant cells and did not form colonies on minimal medium, would have one wild-type nucleus together with a number of *W40A* nuclei. If there were no intraconidial inhibition it would be expected that wild-type colonies would arise at lower dilutions. None has been observed. Experiments to test the extent of intraconidial inhibition are in progress.

In conclusion, it seems to be doubtful whether the back mutation technique in *Neurospora* does, in fact, detect mutants induced by the treatments. Recently, some results obtained by Bryson[13] with *E. coli* suggest that similar conclusions may apply to back mutation techniques in bacteria. Finally, it should be emphasized that, before the results obtained using the back mutation method with any micro-organism can be accepted unreservedly, it must be demonstrated that the mutant cells of the strain used do not inhibit wild-type cells at the concentration at which they are used in the experiments.

I wish to express my warmest gratitude to Dr. D. G. Catcheside for suggesting this investigation and for many helpful suggestions and criticisms. I am indebted to Mr. H. Elborn, who took the photographs. I am the holder of a Commonwealth Scientific and Industrial Research Organization Studentship.

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TRANSFER OF HYDROGEN IN ORGANIC SYSTEMS

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WE are engaged upon a broad study of hydrogen-transfer reactions. This has already given results which are believed to be of general interest and applicability, and we are, therefore, led to present this preliminary summary. Details will be published later.

The term hydrogen-transfer is used in a very wide sense, to include both intramolecular and intermolecular reactions of organic compounds in which covalently bonded hydrogen atoms change their site of attachment. Processes of this type are of great importance in synthetic organic chemistry as well as in biological systems, and many examples have, of course, already been studied very extensively. They include thermal reactions, such as the dehydrogenation of hydroaromatic compounds by quinones; homogeneously catalysed reactions, such as the oxidation-reduction of alcohols and ketones in the presence of metal alkoxides; heterogeneously catalysed reactions such as hydrogenation and dehydrogenation of unsaturated compounds on the surface of transition metals; photochemical reactions, such as the oxidation of primary and secondary alcohols by quinones in visible light; and the multitude of photosensitized reactions, of which the most prominent is photosyn-

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thesis, which involves the dehydrogenation of water by organic acceptors.

Comparatively little attention has been paid in the past to the possible correlation between the hydrogen-donor or hydrogen-acceptor properties of various compounds and structural units in different hydrogen-transfer processes. It is clear that such correlations do exist, but that additional factors, especially stereochemical factors specific to particular reactions and transfer mechanisms, are, as would be expected, superimposed upon intrinsic thermodynamic differences. In order to unify the field and establish scales of hydrogen-affinity, it is necessary to disentangle so far as possible the specific from the general influence; this, in turn, requires a knowledge of the mechanisms of transfer and some quantitative comparisons of structural effects.

Catalysed Disproportionation

A reaction which appeared particularly suitable as a medium for this approach, but which has been very little studied, is the metal-catalysed hydrogen-transfer between organic compounds. It was first observed by Wieland[1], more than thirty years ago, that 1 : 4-dihydronaphthalene readily undergoes disproportionation to naphthalene and tetralin in the presence of palladium black at room temperature, and analogous observations were later made by Boeseken and by Zelinsky and Pawlow[2] with *cyclo*hexadiene and with *cyclo*hexene, the end-products in both these cases being benzene and *cyclo*hexane. Metal-catalysed disproportionation has been shown to occur with many other hydroaromatic compounds[3], but elevated temperatures are usually required. We have confirmed reactions (1) and (2) quantitatively and found that such disproportionations take place with a variety of *cyclo*hexene derivatives (Table 1).

(1)

(2)

Two remarkable features of these reactions are their high rates and the comparatively mild conditions required. The disproportionations can conveniently be followed by determining the disappearance of the *cyclo*-olefin by quantitative addition of halogens or by controlled catalytic hydrogenation of the reaction mixture, and by determining the appearance of the aromatic compound by ultra-violet absorption spectrometry. A question which immediately arises and has not previously been answered is whether a *cyclo*hexadiene intervenes as an intermediate in the disproportionation of *cyclo*hexene. The combined application of the analytical methods mentioned above shows that the concentration of 1 : 3-*cyclo*hexadiene remains less than 1 per cent of that of *cyclo*hexene throughout the reaction. This result, together with the fact that the disproportionation of 1 : 3-*cyclo*hexadiene proceeds with comparable rate under identical conditions (see Table 1), makes it probable (though it does not prove) that 1 : 3-*cyclo*hexadiene is not, in fact, an intermediate in the disproportionation of *cyclo*hexene; and since the intervention of 1 : 4-*cyclo*hexadiene is intrinsically less likely, it seems probable that the removal of all four hydrogen atoms takes place simultaneously.

Table 1. PALLADIUM-CATALYSED DISPROPORTIONATION OF HYDROAROMATIC COMPOUNDS IN TETRAHYDROFURAN SOLUTION AT 65°

Compound	Products	Approximate reaction half-time in minutes*
*cyclo*Hexene	Benzene (1/3 mol.) + *cyclo*hexane (2/3 mol.)	20
1-Methyl*cyclo*hexene	Toluene (1/3 mol.) + methyl*cyclo*hexane (2/3 mol.)	40
4-Methyl*cyclo*hexene	Toluene (1/3 mol.) + methyl*cyclo*hexane (2/3 mol.)	25
Δ^4-Tetrahydrophthalic acid	Phthalic acid (1/3 mol.) + *cyclo*hexane-1 : 2-dicarboxylic acid (2/3 mol.)	50
$\Delta^{1:3}$-*cyclo*Hexadiene	Benzene (2/3 mol.) + *cyclo*hexane (1/3 mol.)	10
$\Delta^{1:4}$-*cyclo*Hexadiene	Benzene (2/3 mol.) + *cyclo*hexane (1/3 mol.)	8
$\Delta^{1:4}$-Dihydrophthalic acid	Phthalic acid (2/3 mol.) + *cyclo*hexane-1 : 2-dicarboxylic acid (1/3 mol.)	15
Δ^1-Dihydronaphthalene	Naphthalene (1/2 mol.) + tetralin (1/2 mol.)	110
Δ^2-Dihydronaphthalene	Naphthalene (1/2 mol.) + tetralin (1/2 mol.)	50

* At the boiling point of *c.* 0·2 molar solutions in the presence of 0·01 molar proportions of palladium black. The solvent was distilled from sodium immediately before use.

Such a process could be pictured as a termolecular reaction on the catalyst surface, with one molecule of *cyclo*hexene acting as donor and two molecules acting as acceptors. It should, in suitable circumstances, give rise to third-order kinetics with respect to *cyclo*hexene, and we have obtained indications that such circumstances can be attained; but the kinetics are necessarily complicated in theory by the adsorption of *cyclo*hexene and desorption of benzene, and in practice by the difficulty of ensuring reproducible conditions of catalyst surface and agitation. Nevertheless, the data leave little doubt that disproportionation is a linked process, the rate-determining step of which involves both the donor and acceptor molecules, and not a two-step process consisting of independent successive dehydrogenation and hydrogenation reactions.

This conclusion is not unexpected. It is borne out by the results described below as well as by the experiments of Linstead, Thomas and others[3], which showed that dehydrogenation with evolution of molecular hydrogen usually requires very much higher temperatures than disproportionation[3]. Dehydrogenation is to be regarded as an alternative reaction of higher energy of activation which cannot effectively compete with disproportionation at low temperatures, but does so at high temperatures.

Catalysed Hydrogen-transfer to Foreign Acceptors (Transfer Hydrogenation)

A disproportionating molecule such as *cyclo*hexene acts both as hydrogen donor and hydrogen acceptor. The ready occurrence of the reaction suggested the possibility of transfer under similar conditions to a molecule of a different species, a foreign acceptor. A few isolated instances of such reactions may be found in the literature[4], usually among rather high-temperature reactions.

We have now found that hydrogen-transfer takes place below 100° in the presence of palladium catalysts between *cyclo*hexene and similar substances as donor and a wide range of acceptors containing ethylenic, acetylenic, azomethine, azo- and nitro-groups, or certain types of activated carbonyl groups (Tables 2 and 3). No appreciable transfer is observed under

Table 2. Palladium-catalysed Hydrogen-transfer Between *cyclo*Hexene and Ethylenic and Other Acceptors*

Acceptor	Product	Solvent	Time (hr.)	% yield†
Oct-1-ene	*n*-Octane	*cyclo*Hexene	21	70
Oct-2-ene	*n*-Octane	,,	52	75
Allylbenzene	Propylbenzene	Tetrahydrofuran	120	90
β-Methylstyrene	Propylbenzene	,,	6	100
Indene	Indane	,,	500	100
Tolane	*cis*-Stilbene	*cyclo*Hexene	3	90
cis-Stilbene	Dibenzyl	,,	20	100
trans-Stilbene	Dibenzyl	Tetrahydrofuran	20	100
Acenaphthylene	Acenaphthene	*cyclo*Hexene	15	100
1 : 1-Diphenylethylene	1 : 1-Diphenylethane	Tetrahydrofuran	43	100
Vinylacetic acid	Butyric acid	*cyclo*Hexene	73	90
Crotonic acid	Butyric acid	,,	69	90
Oleic acid	Stearic acid	,,	17	40
Sorbic acid	Caproic acid	,,	17	95
cis-cis-Muconic acid	Adipic acid	Tetrahydrofuran	30	90‡
Maleic acid	Succinic acid	,,	10	100
Fumaric acid	Succinic acid	,,	10	100
Cinnamic acid	*β*-Phenylpropionic acid	,,	64	85
Benzil	Benzoin	,,	41	45
Benzoquinone	Hydroquinone	*cyclo*Hexene	40	40
Benzylidene aniline	Toluene + aniline	Ethanol	24	45

* At the boiling point of *c.* 0·2–0·5 molar solutions of the acceptor containing a two-fold or larger excess of *cyclo*hexene, in the presence of *c.* 0·01 molar proportions of palladium in the form of palladium black or palladized charcoal.
† Based on acceptor.
‡ Experiment by Mr. J. F. Smith.

these conditions from *cyclo*hexene to potential acceptors containing only ordinary aldehyde, keto, carboxyl or cyano groups, or from *cyclo*hexene to naphthalene, anthracene or phenanthrene. In the positive reactions, competition occurs between 'like' and 'unlike' acceptors, and transfer takes place side by side with disproportionation. It is significant, however, that in the presence of many unlike acceptors, transfer preponderates, although it may proceed more slowly than disproportionation in the absence of the foreign acceptor.

In suitable cases, transfer and disproportionation can both be followed quantitatively, and the results confirm that foreign acceptors invariably slow down the rate of disproportionation. Substances which do not act as acceptors, on the other hand, have varying effects on disproportionation, causing no change in the rate in some cases and a complete stoppage in others. These observations are easily accounted for in terms of adsorption on the catalyst: a necessary though not a sufficient requirement of a positive acceptor is co-adsorption with the donor, while a non-acceptor may be either a compound which is not adsorbed or one which completely displaces the donor from the catalyst and so behaves as a 'poison'.

Hydroaromatic compounds other than *cyclo*hexene as well as hydroheterocyclic compounds can function as donors, and there is some parallelism between the case of disproportionation and of transfer. On the other hand, *cyclo*-olefins such as *cyclo*pentene and *cyclo*heptene and partly hydrogenated open-chain conjugated systems such as 1 : 4-dihydromuconic acid undergo neither disproportionation nor transfer below 100°. It is significant that loss of hydrogen is accompanied by a much larger resonance stabilization (*c.* 40 kcal./mol.) in the case of hydroaromatic donors than in the others (*c.* 5–10 kcal./mol.).

The relative effectiveness of different donors is, however, dependent on the acceptor and bears no simple relation either to the magnitude of the energy gain in passing from the hydroaromatic to the aromatic structure, or to the anticipated electronic effects of substituents on the methylene groups concerned in the transfer. Thus, 9 : 10-dihydroanthracene undergoes catalysed hydrogen-transfer reactions rather less readily than *cyclo*hexene. Similarly, the relative ease of reduction of different acceptors is dependent on the donor and shows certain very characteristic deviations from their behaviour in catalytic hydrogenation with molecular hydrogen; also the influence of substituents is not explicable in terms of the usual electronic effects.

These general features indicate, first, that transfer-hydrogenation, like disproportionation, involves specific donor–acceptor relationships, and secondly, that structural influences operate to a considerable extent through their steric effects on the extent and mode of accommodation on the catalyst and on the donor–acceptor relationship. Effects of this type have been noted previously in the stereochemical orientation of catalytic hydrogenation with molecular hydrogen[5], but they are greatly magnified when the donor is itself an organic molecule.

The results quoted in Tables 1–3 can be interpreted in detail from this point of view, but a fuller discussion is deferred until more complete information is available. It may be mentioned, however, that preliminary kinetic measurements reveal that the reaction-rates show little dependence on the solvent and have uniformly small temperature coefficients, corresponding to energies of activation of less than 5 kcal./mol. Hydrogen-transfer reactions between two organic molecules on a metal surface at a liquid–solid interphase in many respects resemble fundamental biological processes in enzyme systems and provide, we believe, an excellent model for the study of what may be termed 'surface stereochemistry'.

Table 3. Palladium-catalysed Hydrogen-transfer Between *cyclo*Hexene and Nitro-compounds*

Acceptor	Product	Solvent	Time (hr.)	% yield†
1-Nitropropane	Ethylamine	Ether	42	55
Nitrobenzene	Aniline	Tetrahydrofuran	25	100
2-, 3- and 4-Nitrotoluenes	2-, 3- and 4-Toluidines	Ethanol	17	65–100
1-Nitronaphthalene	1-Aminonaphthalene	*cyclo*Hexene	135	75
2- and 4-Nitrophenols	2- and 4-Aminophenols	Tetrahydrofuran	15	65–90
4-Nitroanisole	4-Aminoanisole	*cyclo*Hexene	17	85
2- and 4-Nitrobenzoic acids	2- and 4-Aminobenzoic acids	Ethanol	17	90–100
3- and 4-Nitrobenzonitriles	3- and 4-Aminobenzonitrile	Tetrahydrofuran	40	60–85
3-Nitrobenzaldehyde	3-Aminobenzaldehyde	*cyclo*Hexene	50	<2
2- and 3-Nitroacetophenones	2- and 3-Aminoacetophenones	Ethanol	48	75–95
2-, 3- and 4-Nitroanilines	2-, 3- and 4-Phenylenediamines	,,	50	<2
N-Dimethyl-4-nitroaniline	N : N-Dimethyl-4-phenylenediamine	*cyclo*Hexene	20	65
2-, 3- and 4-Nitroacetanilides	2-, 3- and 4-Aminoacetanilides	Ethanol	17	50–100
1 : 3-Dinitrobenzene	3-Nitroaniline	Tetrahydrofuran	15	80
2 : 4-Dinitrotoluene	2 : 4-Diaminotoluene	Ethanol	17	75
1 : 8-Dinitronaphthalene	1 : 8-Diaminonaphthalene	,,	17	95
2 : 4-Dinitrophenol	2 : 4-Diaminophenol	Tetrahydrofuran	15	95
3 : 5-Dinitrobenzoic acid	3-Amino-5-nitrobenzoic acid	Ethanol	17	60
Picric acid	Picramic acid	Tetrahydrofuran	14	30

* For conditions, see Table 2.
† Based on acceptor.

In addition to its theoretical interest, transfer-hydrogenation of the type described has considerable potentialities as a preparative method[8] and represents a useful alternative to catalytic hydrogenation. Reduction is conveniently effected by heating the acceptor with *cyclo*hexene, a palladium catalyst and (if desired) a solvent such as ether, tetrahydrofuran, dioxan, methanol, ethanol, *cyclo*hexene or benzene under reflux for a few hours. No special apparatus is required and the products are readily isolated in high yields. In this way, for example, maleic acid can be converted quantitatively into succinic acid, stilbene into dibenzyl and nitrobenzene to aniline. Apart from its simplicity, this method is also valuable in virtue of the fact that with compounds containing several potential acceptor functions, transfer-hydrogenation is often more highly specific than ordinary catalytic hydrogenation. Thus, for example, *m*-dinitrobenzene can be converted in almost quantitative yield into *m*-nitroaniline (Table 3).

Uncatalysed Transfers

In the reactions so far discussed, the function of the metal catalyst is regarded as the dual one of 'activating' the transferable hydrogen (that is, reducing the energy required for the fission of the carbon–hydrogen bonds by some kind of metal-hydrogen bonding) and of exerting a favourable steric orienting influence on the donor–acceptor pair. In order to distinguish between factors associated with the catalytic mechanism and intrinsic structural influences, the study of hydrogen-transfer with acceptors sufficiently powerful to react under both catalytic and non-catalytic conditions is desirable. The quinones are a class of acceptors very suitable for this purpose.

The use of quinones as dehydrogenating agents for hydroaromatic and hydroheterocyclic compounds at high temperatures is well known[7], although not widely practised. We find that non-catalysed transfer in such systems can occur under quite mild conditions. Thus the reaction :

$$\text{benzoquinone} + \text{1 : 4-dihydronaphthalene} \rightarrow \text{hydroquinone} + \text{naphthalene}$$

proceeds quantitatively from left to right at 100°. The disappearance of quinone and appearance of hydroquinone can conveniently be followed by titration with titanous chloride and ceric sulphate, respectively, using suitable redox indicators such as methylene blue and diphenylamine sulphonic acid. When adequate precautions are taken to exclude side-reactions, hydrogen transfer is quantitative and exhibits straightforward second-order kinetics (first-order with respect to both donor and acceptor) ; furthermore, the rates of reaction of a number of related quinones show a linear relation to their oxidation-reduction potentials (Table 4). This significant result gives some grounds for confidence in the feasibility of a more general correlation, and the extension of the work to other classes of donors and acceptors is in hand.

Table 4. Uncatalysed Hydrogen-transfer Between 1 : 4-Dihydronaphthalene and Quinones in Phenetole Solution

Quinone	$10^4\ k_2^{101°}$ (gm.-mol./lit./sec.)	E_{Arr} (kcal./mol.)	E_r (in volts)*
Benzoquinone	1·32	20·0	0·711
Toluoquinone	0·428	20·5	0·656
Thymoquinone	0·087	20·5	0·589
1 : 4-Naphthoquinone	0·032	21·0	0·493

* In ethanol at 25° (Conant and Fieser, *J. Amer. Chem. Soc.*, **45**, 2208; 1923).

[1] Wieland, *Ber.*, **45**, 484 (1912).
[2] Boeseken, *Rec. trav. Chim. Pays-Bas*, **37**, 255 (1918). Zelinsky and Pawlow, *Ber.*, **66**, 1420 (1933).
[3] cf. Linstead *et al.*, *J. Chem. Soc.*, 1146 (1937); 1127, 1134, 1139 (1940).
[4] cf. Akabori and Suzuki, *Proc. Imp. Acad. Japan*, **5**, 255 (1929). Kindler and Peschke, *Annalen*, **497**, 193 (1932). Kleiderer and Kornfeld, *J. Org. Chem.*, **13**, 455 (1948). Eschinazi and Bergmann, *J. Amer. Chem. Soc.*, **70**, 5651 (1950). Badcock and Paussacker, *J. Chem. Soc.*, 1373 (1951).
[5] cf. Linstead *et al.*, *J. Amer. Chem. Soc.*, **64**, 1985 *et seq.* (1942).
[6] British Patent Application 1097/51.
[7] cf. Arnold *et al.*, *J. Amer. Chem. Soc.*, **61**, 1407 (1939) ; **62**, 983 (1940).

PLANNING AND BUDGETING OF INDUSTRIAL RESEARCH

THE report of the second Conference of Industrial Research Directors and Managers on the planning and financial control of industrial research, which was organized by the Industrial Research Committee of the Federation of British Industries, has now been published* and gives in full the introductory papers to each of the first four sessions and Dr. P. Dunsheath's final summing-up at the fifth. A selection of contributions to the various discussions is also included.

C. Paine, of Imperial Chemical Industries, Ltd., dealt with the planning and budgeting of research in a large organization and made some points of general interest, particularly in regard to long-range research, after emphasizing that the availability of good-quality leaders for further units of 6–10 men is one limiting factor on the rate at which a research organization and its budget can grow efficiently. The inception of long-term projects, arising as they do from new ideas or imaginative leaps by an individual mind, cannot be planned but only fostered. Having recruited the best quality of man available and assessed his experimental skill, imagination and technical judgment in the context of a shorter-term project, management can only exercise faith in that man and in its own judgment of him when he proposes a long-term topic for research. It is a function of management to seek constantly those factors of environment, stimulus and encouragement which assist a good man to function imaginatively at high level. A highly original exploratory project is not necessarily best served by using big battalions at the outset, and a research organization must always have reasonable opportunity and encouragement to pursue some of its own chance observations, however irrelevant these may appear in the early stages.

The long-term investigations which are sometimes referred to as 'background research', continued Mr. Paine, require a man of first-class intellectual capacity and imagination, but it is good practice to provide him with a research colleague with great experience and skill in the technology of related short-term problems. Apart from the selection of research projects, in which the essential questions are, first—What are the best topics and ideas to investigate ?—and then—Can we afford to investigate all or only some of these ?—there is the more difficult problem

* Report of the Second Conference of Industrial Research Directors and Managers : the Planning and Financial Control of Industrial Research. Organised by the F.B.I. Industrial Research Committee and held at Ashorne Hill, Leamington Spa, 10 to 12 November 1950. Pp. 88. (London : Federation of British Industries, 1951.) 3*s*.

of when to stop a project. Mr. Paine pointed out that this is a matter of the persistent sharpening of technical judgment and instinct by hard experience. Arbitrary intervention by management without the fullest attempt to understand and utilize the judgment of the research personnel involved almost invariably results in stopping the wrong project.

Other subjects of general interest raised in the discussions at the conference included the transfer and flexibility of staff, the origin of research problems and ideas, in which distinction was drawn between the two aspects, discovery and invention, and the costing and the evaluation of research. Some of the difficulties in, and objections to, costing research were discussed, and the importance was emphasized of making costing as simple as possible, accepting it as an approximate activity and putting it over intelligently to the research staff. There was general agreement that evaluation of research work is desirable; but the difficulties of expressing its value in financial terms are practically insuperable.

CONFERENCE ON DIELECTRICS

A CONFERENCE on dielectrics was held in Liverpool during July 23–25. The Conference was organized by the Department of Theoretical Physics of the University of Liverpool, in collaboration with the Department of Extra-Mural Studies of the University, the Institute of Physics and the Electrical Research Association.

Dielectrics is a subject which brings together people with very different backgrounds, including experimental and theoretical physicists, chemists and electrical engineers. Each group of subjects was therefore introduced by a fairly long review, summarizing the principal aspects or the recent advances connected with the subject for the benefit of those who are not working in that particular field. The reviews were followed by original contributions. These unfortunately had to be rather short because of the large number of papers presented.

The meetings were held in one of the residential halls of the University situated outside the city in pleasant surroundings, and all the meals were also served in the same building. The sittings were fairly short with long intervals for coffee, lunch and tea, which all helped to give plenty of opportunity for private discussions, which was one of the principal aims of the conference.

About a hundred and sixty people attended the meetings, a third of whom came from overseas. The distinguished visitors from abroad included E. Bauer (Paris), C. J. F. Böttcher (Leyden), R. H. Cole (Brown University), R. M. Fuoss (Yale University), M. Magat (Paris), J. C. Slater (Massachusetts Institute of Technology) and C. P. Smyth (Princeton).

The field which showed the greatest advance since the conference on the same subject held in Bristol in 1946 was that of the ferro-electrics. While the reasons for ferro-electricity were obscure in 1946, the main principles are now well understood.

A considerable amount of work was presented on the phase transitions of solid hydrogen halides, but the state of affairs is very complicated and a complete explanation of the connexion between the dielectric and structural changes of these materials at the transitions is still outstanding. Important results have been obtained on the electrical breakdown of liquids, and significant advances were also presented in many other fields.

The most controversial subject turned out to be the breakdown of solids.

The first day started with a short introduction to the Conference by H. Fröhlich. This was followed by a review by J. C. Slater of the theory of ferro-electricity and permanent polarization. Prof. Slater presented his subject in a remarkably clear way, so that even those who had known nothing about it previously grasped the principles of ferro-electricity. A. F. Devonshire explained that the electric and elastic constants of the non-cubic phases of barium titanate can be calculated from the constants of the cubic phase; but in order to use these results for the calculation of the constants of a ceramic, which is polycrystalline, one would have to average over crystallographic directions and it is not known how the averaging process is to be carried out. D. M. Finlayson reported measurements on potassium dihydrogen phosphate which showed that both the 'free' and the 'clamped' dielectric constants become independent of temperature at about 60° K., whereas current theories suggest that this should occur at about 100° K. The discrepancy indicates that down to 60° K. small fields can induce a movement of the domain walls.

K. Huang presented two phenomenological equations and suggested that these make the treatment of the interaction of an ionic crystal with an electric field easier than previous methods. He showed how these equations can be applied to various problems, in particular to the transverse optical vibrations in the crystal. Two papers, by A. Schallamach and by C. G. Garton, discussed the distribution of relaxation times in amorphous materials. L. Hartshorn reviewed methods used for the measurement of dielectric constants with high accuracy and discussed the practical limitations. He explained why the accuracy is highest in the centimetre region. This review was followed by many very short communications concerning experimental methods.

The second day started with C. P. Smyth's excellent review on the connexion between chemical structure and dielectric properties. Prof. Smyth also mentioned some recent results concerning long-chain alcohols in long-chain organic solvents. For alcohols of moderate chain-length the relaxation time is independent of the viscosity of the solvent, which shows that the forces governing molecular rotation are not connected with the flow viscosity. But for alcohols with very long chains, the relaxation time is not independent of the flow viscosity of the solvent. J. Lamb presented measurements on solid penta-methyl-chlor-benzene and similar materials, which exhibit excellent Debye curves with scarcely any spread of relaxation times. These materials are so like the ideal theoretical model in behaviour because their molecules are very rigid and have very nearly circular cross-sections. R. H. Cole showed absorption curves of glycerine derivatives. He showed, with the aid of Cole-Cole plots, that a number of these compounds possess two distinct relaxation mechanisms. He also mentioned measurements on solid hydrogen bromide and said that by annealing it between the electrodes one gets rid of hysteresis effects and at the lowest transition the dielectric constant then reaches values of about 200. D. H. Whiffen said that a number of non-polar liquids exhibit a very small dielectric absorption in the

ultra-high-frequency range. There is no theoretical reason why such a small absorption should not take place and Dr. Whiffen offered one possible explanation. M. Magat discussed the absorption of various organic materials in the centimetre range. Aliphatic alcohols exhibit two distinct dispersion regions, both of which are due to relaxation mechanisms because both are strongly temperature-dependent. F. J. Lehany summarized the results obtained in the National Standards Laboratory, Sydney, on crystalline secondary alcohols. B. Szigeti discussed the theory of molecular torsion in long-chain ketones and showed that this mechanism leads to a polarizability which is very large compared with the values of 'vibrational' or 'atomic' polarizability encountered in most other substances. W. G. Oakes said that both crystalline rubber and polythene exhibit two distinct relaxation mechanisms. If the crystallinity of rubber is reduced, one of the absorption maxima disappears. E. Rushton discussed the dielectric properties of liquid silicones.

The third day started with two talks on solid hydrogen chloride and hydrogen bromide, by E. Bauer and J. G. Powles. In the lowest-temperature phase, hydrogen bromide shows two dispersion regions due to relaxation mechanisms, and one of these disappears at the first transition. Prof. Bauer thinks that in the lowest-temperature phase hydrogen bromide should be considered as 'anti-ferro-electric'. In the same phase there is a large difference between the dielectric behaviour of hydrogen bromide and deuterium bromide, and Dr. Powles explained this by assuming that at very low temperatures polarization can take place in the former by means of a tunnel effect.

R. Freymann demonstrated that dielectric measurements can distinguish between adsorbed and chemically-bound water in solids. V. Daniel discussed experiments which showed that very small amounts of impurities, in particular water, can have a very large effect on the dielectric properties near the melting point. C. Dodd and G. N. Roberts said that the dielectric properties of a supercooled liquid exhibit a change at the melting point. J. J. O'Dwyer derived a phenomenological relation between the polarization and the electric field for very strong fields when the relationship is not linear. H. Pelzer spoke on the energy loss and effective mass of slow electrons in ionic crystals.

The discussion on dielectric breakdown was opened by S. Whitehead, who reviewed the influence of theoretical developments on engineering practice. He stated that from the practical point of view little interest can be attached to the further improvements of the best dielectrics; much more advantage can be gained from the improvement of those dielectrics which are not very good at present. K. A. Macfadyen reported measurements on the breakdown of liquids and concluded that liquids do not conform to the existing breakdown theories which have been developed for crystals or amorphous substances. Talking on breakdown in solids, W. Franz developed the view that several existing theories can account for the known experimental facts. H. B. Callen, on the other hand, maintained that preference can be given to one particular theory which alone is able to explain the fact that the breakdown path favours certain crystallographic directions. The conclusions of both Prof. Franz and Dr. Callen were contradicted by Prof. Fröhlich, and Dr. Callen's arguments were also criticized by Dr. Huang. With this discussion the conference came to an end.

Prior to the Conference there was a three-day 'summer school' on the theory of dielectrics. The lecturers were Prof. H. Fröhlich and Dr. B. Szigeti, and one lecture was also given by Dr. J. G. Powles. The school was arranged for the benefit of experimental physicists with theoretical interests. B. Szigeti

BOSE INSTITUTE, CALCUTTA

ANNIVERSARY MEETING

THE thirty-fourth anniversary of the Bose Institute was celebrated on November 30, when Prof. P. C. Mahalanobis, statistical adviser to the Cabinet, Government of India, gave the thirteenth Acharya Jagadish Chandra Bose Memorial Lecture. His subject was "Statistical Methods in Relation to National Development". His Excellency Dr. H. C. Mookherjee, Governor of West Bengal, presided over the meeting.

In presenting his annual report, Dr. D. M. Bose, director of the Institute, referred to its severe loss through the death of Lady Abala Bose, widow of Acharya Bose, and of Prof. N. C. Nag, who served as assistant director and was a trusted colleague of the founder. Speaking of Lady Bose, Dr. D. M. Bose said that those on whom the direction of the Bose Institute devolved after the death of the founder will recall with gratitude the help they constantly received from Lady Bose, by her advice, and by her presence at Council and governing body meetings. He then gave a short sketch of the life of Lady Bose and of the fifty years of her eventful married life, which terminated with the death of Acharya Bose in 1937. "It would be rare in any country," he said, "to find such instances of two gifted and strong personalities with similar ideals and in many ways with complementary characters, united in matrimony and fully utilizing their inborn gifts to the service of their country and of their fellow beings. One of them was temperamental, artistic, with a romantic imagination, dreaming of the resuscitation of the achievements of ancient India as exemplified in Taxila, Nalanda and Ajanta, interested more in putting concrete shape to his ideas rather than in individuals; the other calm and unruffled, with intuitive wisdom and human sympathy, which deepened with age and experience. After the death of her husband a new chapter of her life commenced." He also described her work on behalf of widows and other distressed women of Bengal through the institutions founded and managed by her for a period of thirty years.

Dr. Bose then gave an account of the principal sources of income of the Institute, the total income of which during the present year is expected to exceed Rs. 300,000. The Institute has received during the past three years a total non-recurring grant of about Rs. 300,000, of which Rs. 180,000 was contributed by the Government of India and Rs. 120,000 by the Sir J. C. Bose Trust No. 1. This amount has been spent principally in the erection and equipment of a new laboratory built on the top of the Institute lecture hall, and in the purchase of equipment for the workshop and laboratories.

The Government of West Bengal has agreed to acquire for the Falta Agricultural Experiment Station of the Bose Institute about 58 bighas of Khas Mahal land at an estimated cost of about Rs. 48,000, of which the Government will contribute

one-third and the balance will be met out of a donation from the Sir J. C. Bose Trust No. 1. Plans have been approved for the erection of a two-storied structure of floor area about 3,500 sq. ft. at the south-west corner of the Institute quadrangle, at an estimated cost of Rs. 80,000, of which half has been given by the Sir J. C. Bose Trust No. 1, and the Central Government has been asked to contribute an equal amount. This building will house the workshop and the library, which have outgrown their present accommodation. At the Mayapuri Research Station, Darjeeling, a glass-house and a microbiological laboratory have been fitted up for the study of potato virus disease and for the survey of the distribution, at different altitudes, of soil micro-organisms in cultivated and virgin soils of the Darjeeling district.

Two research fellows recently returned from the United States and Canada are constructing apparatus for cosmic ray investigations, which will be taken to Darjeeling next spring for experiments at high altitudes. These include a large pressure ionization chamber, counter telescopes, a large rectangular Wilson chamber, and a small Wilson chamber placed in the field of a medium-sized electromagnet consuming 25 kW.

The cytological and mutagenic action of X-rays, ultra-violet rays, ultrasonic radiation, as well as of different chemical reagents, is being investigated. As reported previously, improved mutants of jute have been obtained with X-ray treatment; recently plants grown from irradiated *Sesamum* seeds appear to give a promising yield of oil-seeds. The effect of penicillin in inhibiting the growth of soil organisms and producing cytological effects on plant cells has been studied. Pericillin has been found to prevent the transformation of tadpoles into frogs; tadpoles kept for some time in a dilute penicillin solution and then transformed to their normal habitat in water have continued to grow and increase in size for six months without metamorphosing into frogs.

OVERSEAS FOOD CORPORATION

THE report of the Overseas Food Corporation*, to which are appended the accounts for the year ended March 31, 1951, some notes on land-use surveys and the report of the Scientific Department for the crop year 1949–50, records steady progress towards the decentralization foreshadowed in the previous report and rapid implementation of the recommendations of the Kongwa Working Party's report of September 1950.

Before the 1950–51 planting season, agricultural operations were reduced to the four comparatively small farms recommended. Management of smaller acreages by the more experienced farmers and a better distribution of rainfall in the critical months of January and February demonstrated the potential of the area more favourably. Land clearing in Urambo was virtually completed at 65,000 acres, and full-scale farming established with 45,000 acres planted. Clearing in the Southern Province was limited to the 60,000 acres recommended as a first stage in the revised plan presented to Parliament in January 1951, and all money advanced to the Corporation for the East African Groundnut Scheme up to March 31, 1951, has been written off. Hand labour is being substituted for the mechanical processes of piling the felled trees and excavating stumps.

* Overseas Food Corporation. Annual Report and Statement of Accounts for the Year ended 31st March 1951. Pp. iv+82. (London: H.M. Stationery Office, 1951.) 3*s.* net.

The notes on land-use surveys indicate the contribution made by the Corporation to the technique involved; waste of much labour in clearing unsuitable land both in Urambo and the Southern Province has been saved by land-use surveys and soil conservation surveys. Observations in all areas confirmed the view that consistent and informed consideration must be given to the intricate problems of the loss of soil and soluble plant foods through surface wash and the leaching of the principal plant foods during periods of early and high-intensity rainfall. Demarcation technique has been improved by a method developed locally in the use of aerial photographs, and encouraging results were obtained in a series of controlled experiments in the artificial precipitation of rain at Kongwa, using the silver iodide technique.

Virginia tobacco trials at Urambo were encouraging, both as regard the growth and health of the plants and the quality of the leaf from the barns. Cotton trials in all three regions showed fair to good growth, but 'stainer' attack threatens to be an economic problem. Encouraging results were obtained in trials of several varieties of rice on thirty acres at Urambo. At Kongwa the 1949–50 harvest yield per acre was 244 lb. shelled groundnuts, 99 lb. cleaned sunflower and 1,085 lb. shelled maize.

The Scientific Department continued to work on lines laid down in previous seasons, but little detailed work on sunflower was conducted in 1949–50 and 1950–51, since until a self-pollinating type can be developed which is also dwarf, drought-resistant and uniform for combining, other agronomic work on this crop is of little significance. At Urambo a system of so-called 'broad lands' has been developed which holds much promise for control of surface 'wash', an insidious and very serious cause of reduced yields, and this system is to be applied more generally in experimental work. The classification of soil types at Kongwa and in the Southern Province was completed for practical purposes.

Soil fertility studies in 1949–50 showed widespread and important phosphate deficiencies in most soils of the Southern Province and confirmed the general phosphate deficiency of the Kongwa soils. The principal plant-food deficiency at Urambo is nitrogen. This deficiency was more prominent in 1950–51 and may be expected to increase unless remedied by agricultural practice, such as adoption of measures to check the mineralization and leaching of nitrogen.

Work on soil-borne diseases has shown the presence at Urambo and in the Southern Province of *Sclerotium rolfsii*, a very serious disease of groundnuts and other crops in South Africa, although the incidence is at present small. The main plant disease with which the Department is concerned continues to be the rosette disease of groundnuts, and detailed field studies have continued on the biology of the aphis vector and its relation with predators, and on the carry-over of the disease in dry-season volunteer groundnuts. The use of systemic insecticides for controlling secondary multiplication of aphides is also being studied. A valuable degree of control of termite attack on standing crops has been obtained experimentally by the use of 'Gammexane', placed near the seed, as a soil fumigant.

The Operational Research Unit continued to work along the broad lines described in the annual report for 1949–50, and a new digger–lifter–windrower and a new spray winch were developed. The East African Scientific Committee met twice during the year.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Weather on Traffic Flow

In order to estimate trends in road traffic, censuses were held, in conjunction with the Ministry of Transport, at twenty-one selected points over Great Britain during the weeks August 15–21, 1949, and August 14–20, 1950. In general, the weather was fine during the 1949 census week and wet during the 1950 one. A comparison of the traffic flows for the two Sundays (1949 and 1950) showed a very marked reduction in the flow for 1950, when, owing to the lifting of petrol restrictions, it would have been expected to show an increase. It seemed likely that this observed reduction was due to weather conditions, and examination of the traffic and weather data has shown that a high negative correlation exists between rainfall and traffic. For example, if we compare the total number of solo motor-cycles observed on each of the days Monday to Friday in the 1950 census with the daily rainfall (the average of the rainfall recorded at the meteorological stations nearest the census points), the coefficient of correlation is $-0{\cdot}91$ (significant at the 5 per cent level). For the two Sundays, we must use a different method; we compare the percentage change, between 1949 and 1950, in flow of solo motor-cycles at each of the twenty-one points with the amount by which the rainfall at each point in the week in 1950 exceeded that in 1949. This gives a correlation of $-0{\cdot}72$ (significant at the 1 per cent level). Results of calculations such as these are summarized in Table 1. As the two Saturdays were both fairly fine, no direct method was available for determining the weather effect; but for the purpose of Table 2 it has been assumed that it will lie between that for Monday to Friday and that for Sunday.

In view of these values, it is necessary to adjust the census figures obtained in 1950 to allow for the effect of the rainfall during that census week, before comparisons of traffic can be made. The magnitude of this adjustment can be judged from Table 2.

It will be noted that, had it not been for the correction for rainfall, the results of this one-week census would have suggested that Sunday traffic was less in 1950 than 1949, in spite of the de-rationing of petrol in May 1950. The corrected figures indicate that mechanically propelled traffic was greater on Sundays as well as on other days, although pedal-cycle traffic was lower in 1950, even when corrected. It is possible that other factors, not yet investigated, have similar effects, and evidently considerable caution must be used in making comparisons between the results of traffic censuses carried out over such short periods as single weeks.

Table 1. Reduction in Traffic caused by Rainfall

Type of vehicle	Monday to Friday		Sunday	
	Percentage reduction in traffic flow per mm. of rain	Standard error	Percentage reduction in traffic flow per mm. of rain	Standard error
Solo motor-cycles	5·5	1·4	5·7	1·3
Motor-cycle combinations	6·0	1·7	6·3	2·7
Cars and taxis	1·3	0·2	3·1	0·8
Public service vehicles	0	—	1·4	0·6
Goods vehicles, etc.	0	—	1·1	1·1
Pedal cycles	2·9	0·1	6·3	1·3
Total, excluding pedal cycles	1·0	0·1	3·2	0·7
Total	1·2	0·1	4·0	0·7

Table 2. Comparison of Traffic Flows in August 1949 and August 1950, showing the Effect of Rainfall

Type of vehicle	Traffic in August 1950 as a percentage of that in August 1949			
	Observed : corrected for effect of rainfall			
	Monday to Friday	Saturday	Sunday	All days
Solo motor-cycles	134 : 160	128 : 132	77 : 111	120 : 143
Motor-cycle combinations	127 : 155	129 : 133	69 : 105	110 : 135
Cars and taxis	125 : 130	124 : 125	101 : 122	121 : 128
Public service vehicles	101 : 101	102 : 102	95 : 102	101 : 101
Goods vehicles, etc.	103 : 103	107 : 107	101 : 107	103 : 103
Pedal cycles	80 : 88	85 : 87	42 : 64	75 : 84
Total, excluding pedal cycles	113 : 117	117 : 119	97 : 117	112 : 117
Total	108 : 111	113 : 114	86 : 109	106 : 111

The work described above was carried out as part of the programme of the Road Research Board of the Department of Scientific and Industrial Research. This communication is published by permission of the Director of Road Research.

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Sept. 11.

A New Determination of the Velocity of Electromagnetic Radiation by Microwave Interferometry

The free-space phase velocity of microwaves of length 1·25 cm. and frequency 24,000 Mc./s. has been measured by a new method.

In essentials the apparatus used is equivalent to the well-known Michelson optical interferometer. Microwave energy at constant frequency from a stabilized klystron oscillator is transmitted by means of a hybrid junction ('magic-T'), acting as beam divider, along the two arms of the interferometer. The beam in one arm passes through a transmitting horn into a very large room, over distances up to 21·5 m., towards a movable metal reflector. Here the radiation is reflected back along its path to the horn, through the beam divider, and into a detector. The other arm is enclosed in a short length of wave-guide carrying attenuators and terminating at the face of an adjustable shorting piston. Here also the energy is reflected back to the beam divider, and interference between the two beams takes place at the detector. The detecting device records the energy minima as the movable reflector is displaced. The distance between consecutive minima is nominally equal to half the wave-length of the radiation in the prevailing atmospheric conditions.

To make an observation the movable reflector is displaced through an exact integral number of minima by means of accurately calibrated end-gauges and a micrometer. The total displacement used was

about 162 cm., and since the settings on the position of an interference minimum were generally reproducible to within $\pm 3\mu$, the apparent wavelength in air could be established from a single displacement to an accuracy of about ± 3 parts in 10^6.

Because the lateral dimensions of the transmitting horn and reflector extend over but a few wavelengths, diffraction produces an error in the result. This error can be eliminated if displacement measurements are made over the same number of minima when the mean position of the reflector is set at two or more different distances from the transmitting horn. Another, smaller, source of error successfully eliminated was that produced by stray reflexions from fixed objects in the room.

Velocity is obtained from the product of frequency and corrected wave-length. Frequency can be measured by comparing the microwave oscillator against a high harmonic of a standard quartz oscillator[1]. The results were reduced to the vacuum condition by means of equations derived by Essen and Froome[1,2] from measurements of the refractive indices of atmospheric gases and water vapour at a frequency of 24,000 Mc./s.

The result for the vacuum velocity, obtained from thirty-six observations by three observers, is :

$$c_0 = 299{,}792{\cdot}6 \pm 0{\cdot}7 \text{ km./s.},$$

where the variation shown represents the statistical combination of standard deviation with reasonable estimates of possible systematic errors. This result confirms the general tendency of recent determinations by other methods (see reviews by Essen[3], Bearden and Watts[4], Stille[5]) to yield values higher by 13–20 km./s. from that generally accepted a decade ago. The new result lies well within this range. A full account of the determination will be published elsewhere.

I particularly wish to acknowledge the continued encouragement received from Mr. H. Barrell, the originator of the project. The work described is part of the research programme of the National Physical Laboratory, and this communication is published by permission of the Director of the Laboratory.

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Oct. 31.

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Combined Phase-contrast and Interference-contrast Microscopy

In interference microscopy[1], contrast in transparent objects is obtained by adding a coherent wave of a certain phase and amplitude to the wave which has passed through the object. In the usual vector representation[2], this is equivalent to shifting the origin of the vector circle representing the image. It is clear that, in principle at least, it is possible to add further vectors representing other coherent waves and thus to shift the origin to different new positions. We may thus have consecutive or successive interference contrast.

Phase-contrast is essentially an interference method[3] in which the origin of the vector circle is shifted by rotating a vector, a process which is, of course, equivalent to adding a different vector. One or more of the stages of consecutive interference may therefore be a phase-contrast procedure. In an 'ideal' interference-contrast method there might be no point in carrying out successive steps, since any desired origin could be chosen by selecting the right sort of coherent wave in the first step. Practical methods of interference microscopy are not usually ideal, however, in that the interference fringes cannot always be made infinitely broad. In such cases the new origin will not be fixed, but will vary in different parts of the field of view. Thus, in passing between two fringes, different parts of an object may show a mixture of positive and negative *A*-type, and positive and negative *B*-type contrast. This multiplicity of effects results in bizarre appearances which are very difficult to interpret. It was probably for this reason that Merton[1] stated that poor results were obtained with his method of interference microscopy when the fringes were closely spaced.

Unstained oral epithelial cells. Combined phase-contrast and interference-contrast. × 200

According to a detailed theory which will be published elsewhere, if interference-contrast is combined with phase-contrast, the result will be that the new origin of the vector circle still varies between the fringes but in a different way from before. Thus, if a 90° positive *A*-type phase-contrast objective is used, the general result will be approximately 90° positive phase-contrast, but with the equivalent of varying absorption of the direct light in different parts of the field. This result is shown in the accompanying photograph of epithelial cells taken by a combination of the Merton method with a Cooke 10 × phase-contrast objective. No negative contrast is visible, and the *B*-type contrast which is usually detrimental to the fine detail in biological objects is much diminished or altogether absent. The photograph cannot show one remarkable feature of the method, namely, the beautiful colour effects obtained by using unfiltered mercury or tungsten light. For photography, Kodak microfile panchromatic film was used with a high-pressure mercury lamp and mercury yellow filter. The exposure time was two seconds, and the degree of contrast so high that low-contrast developer and paper had to be used.

It is seen that in general the cells appear dark against a light fringe and *vice versa*. Under the microscope they are vividly coloured against a back-

ground of another colour. The spacing of the fringes is not critical. In fact, narrow fringes are now preferable. Good results were obtained with objectives of higher aperture, including oil-immersion objectives, but the fringes become broader in relation to the field of view. It is well known that, owing to the finite dimensions of the phase plate, practical phase-contrast microscopy is relatively insensitive to slow changes of phase. In fact, the darkening of the image is not a pure function of the phase change alone, but of the gradient of the latter as well. Thus, discontinuities of phase such as occur at small granules and edges tend to be exaggerated. By combining phase-contrast with interference-contrast, slow changes of phase such as occur within broad details can be made apparent as variations in intensity or colour.

The combined method has brought to light the necessity for a new 'degree of freedom' not hitherto suspected. Further degrees of freedom are obtainable by combining a variable interference system, such as that of Dyson[1], with a variable phase and amplitude microscope[2], and experiments of this type are now in progress. It should be pointed out that interference-contrast can also be used in conjunction with other types of illumination, such as the *Schlieren* method and its modifications. Full details of the theory and practice of these methods will be given elsewhere.

I wish to acknowledge the help received as Johnston, Lawrence and Moseley Research Fellow of the Royal Society. I am also indebted to the Research Department of Messrs. Hilger and Watts, Ltd., for the provision of semi-rhodiumized slides and coverslips.

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Oct. 5.

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Hydrogen Reduction of Tungsten Trioxide

The existence of two tungsten oxides (β- and γ-oxides) intermediate in composition between WO_2 and WO_3 has been well established by Glemser and Sauer[1] and Hägg and Magnéli[2,3] using X-ray diffraction methods.

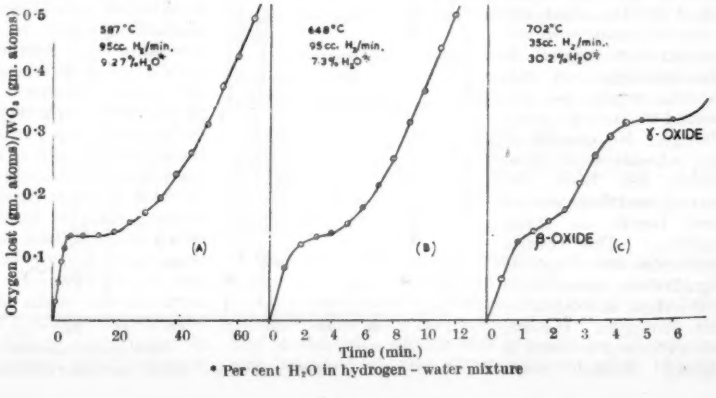
The time curves for the reduction, obtained by a continuous weighing technique, showed well-defined inflexions, when moist hydrogen or low flow-rates of hydrogen were used, which corresponded to these intermediate oxides. The position of the inflexions varied slightly but corresponded to oxide compositions which fell within the homogeneity ranges found by Hägg and Magnéli.

The average compositions for the β- and γ-oxides were $WO_{2.88}$ and $WO_{2.70}$ respectively, as compared with the stoichiometric compositions suggested by Hägg and Magnéli, namely, $WO_{2.90}$ and $WO_{2.75}$. It is very probable that the formation of these oxides by reduction will tend to give oxygen-deficient compounds. X-ray powder photographs of partially reduced samples showed that these inflexions corresponded to homogeneous compounds with two-phase regions on either side. The γ-oxide inflexion was never observed at about 585° C. and was only found at 645° C. when very low flow-rates were used.

The presence of water vapour increases the induction period which occurs before one oxide undergoes reduction to the next lower oxide, presumably by re-oxidizing the nuclei of the new phase and thereby decreasing the overall rate of nucleation.

After further reduction, the reaction ultimately slowed down considerably, at a stage beyond the point corresponding to the WO_2 composition, and this final slow reaction was due to reduction of WO_2 to tungsten. At this stage the product contained approximately equal amounts of α- (the normal body-centred cubic form) and β- ($a = 5{\cdot}04$ A.) tungsten, when reduction was carried out below about 650° C. Above 650° C. only traces of β-tungsten were ever found, together with α-tungsten.

It was evident, particularly below 650° C., that the rate of reduction of WO_2, as shown by the curves, would not account for reduction past the WO_2-stage, even assuming that the first traces formed at once began to undergo reduction. Later results indicated that β-tungsten was formed by direct reduction of β-oxide, for the X-ray powder photograph of a sample partially reduced at 584° C. to the composition $WO_{2.885}$ showed the presence of only β-oxide (~ 85 per cent) and β-tungsten (~ 15 per cent). Other samples, partially reduced at 584°–686° C., contained β-tungsten and WO_2 together with the β- or γ-oxide; but no partially reduced sample, even at 718° C., was ever found to contain normal tungsten unaccompanied by the β-form. There is therefore no indication that α-tungsten is produced directly from any oxide other than WO_2. Thus it appears that the α-tungsten found in the final products obtained below 648° C., and as low as 542° C., by reduction to the point at which the rate becomes negligible, is formed by slow transformation of the β-tungsten. If this is so, then the β- to α-tungsten transition is not in the region of 650° C. as has been suggested[4]. The transformation is apparently not rapid, for the β-form has been found in samples partially reduced at 718° C.



Rooksby has also obtained the β-form by reduction at 800° C. [5].

It is hoped to publish a more detailed account of this work elsewhere. I wish to express my thanks to Mr. M. G. Harwood, who was responsible for the X-ray crystallography, and to Dr. J. A. M. van Moll and the directors of Philips Electrical, Ltd., for permission to publish this work.

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Infra-Red Studies of Solvent Effects

Two main theories have been put forward to explain the properties, particularly the electronic absorption spectra, of solutions of iodine (or bromine) in various solvents. The most widely held theory[1,2] maintains that 1 : 1 solvent-solute complexes are formed, whereas Bayliss and Rees[3] and Bayliss[4] explain the observed effects in terms of the perturbation introduced by the cage of solvent molecules surrounding each solute molecule. To obtain further information regarding the nature of these solvent effects, we have recorded the vibrational absorption spectra over the range 2·5–25 μ (4,000–400 cm.$^{-1}$) of solutions of iodine in (*a*) benzene (1 part) plus carbon tetrachloride (5 parts), (*b*) ether, (*c*) pyridine. In each case saturated solutions at room temperature were used.

For solutions (*a*) and (*b*) the spectra were, within the limits of experimental error, identical with the spectra of the solvents alone and there was no detectable broadening of the absorption bands. This observation is in accord with the cage theory, since the presence of a complex in solution should introduce major changes in the spectra. In particular, vibrations such as the totally symmetrical stretching vibrations of benzene at 992 cm.$^{-1}$ (C—C) and at 3,062 cm.$^{-1}$ (C—H), which are infra-red inactive in the vapour but appear in the spectrum of the liquid, would be expected to undergo some change. No change in the intensities of these bands has been observed, and there are no new bands in these regions. The results with ether are of special significance, since ether and iodine, according to the 'complex' theory, are supposed to form a tightly bound compound and thus the spectrum should be quite different from that of ether alone. Mulliken[3] considers that the ether–iodine complex has a structure in which the lone pair of electrons on the oxygen atom is partially transferred to the iodine atom. Some change in the C—O—C stretching frequencies in ether would then be expected. These frequencies occur at 1,152 cm.$^{-1}$ and 935 cm.$^{-1}$ in diethyl ether[5]. No shifts of these two bands were observed and no new bands appeared.

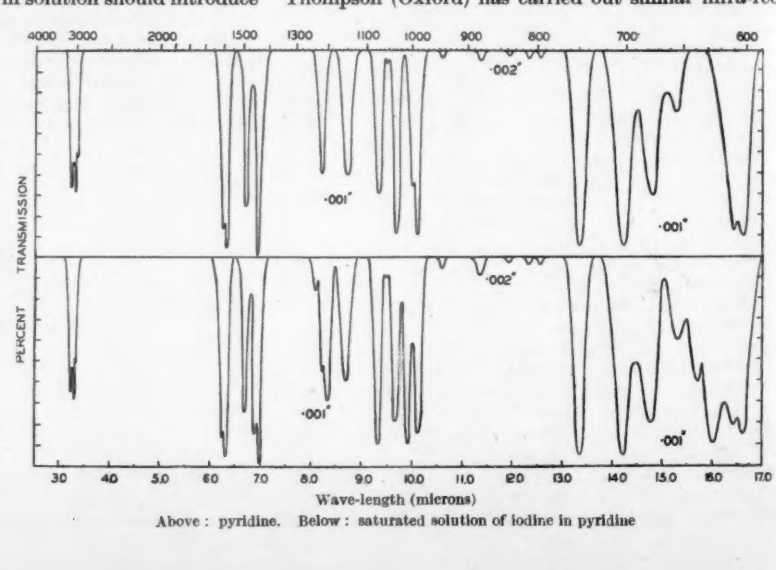
The existence of a crystalline complex of pyridine and iodine, when taken together with the known properties of pyridine solutions, suggests that the complex exists also in solution. This is in full accord with the infra-red evidence, which shows that solutions of iodine and pyridine give absorption spectra containing well-defined absorption bands additional to those in the spectrum of pyridine alone. The graph shows the infra-red spectra of pyridine and a saturated solution of iodine in pyridine. The frequencies of the bands are shown in the accompanying table.

Pyridine	Pyridine + Iodine	Pyridine	Pyridine + Iodine	Pyridine	Pyridine + Iodine
604·7	604·5	880	884·5		1238
610·3	610·0	941	940·6	1438·2	1440
	627	991	990		1447·7
	638	997	996	1483·1	1482·6
656	656		1005	1582	1580·3
677	677	1031	1029	1598	1593·4
704	699	1051	1050	3005	3000
749	749	1069	1064	3032	3026
799	798·6	1148	1145	3056	3056
811	813		1209·7	3079	3079
837	847	1218	1215·5		

There is no obvious correlation between the frequencies that are split by the addition of iodine and the type of vibration involved.

The above results are strong evidence that 'complex' formation can be readily detected by means of infra-red spectra and indicate that in solvents (*a*) and (*b*) no complex is formed.

A full report of these investigations will be published elsewhere. We understand that Dr. H. W. Thompson (Oxford) has carried out similar infra-red



Above : pyridine. Below : saturated solution of iodine in pyridine

spectroscopic studies and will be reporting them independently.

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Recovery of Radioactive Iodine from Urine

Since the cost of radioactive iodine being used in New Zealand is increased by air-freight charges and radioactive decay during transit to about four times that obtaining in the United Kingdom, methods for the recovery of radioactive iodine from the urine of patients are of especial concern to the therapeutic programme of the Endocrinology Research Committee. While other methods have been used with comparative success, the silver precipitation[1] method seemed to offer the best prospects of development. The primary difficulty is that the addition of small amounts of silver nitrate to urine results in the formation of colloidal silver halides. Craig and Jackson[1] overcame this by the addition of larger amounts of silver nitrate and by allowing five hours or longer for the halides to sediment. It has been found here that the formation of colloidal silver iodide can be avoided by precipitating the silver nitrate as chloride in a suspension of Gooch asbestos before contact with the urine. The method of Craig and Jackson is considerably improved if, instead of silver nitrate, such a preformed silver chloride asbestos suspension is added to the acidified urine. The iodide of the urine is fixed on the precipitate, which can be filtered off immediately and washed with dilute sulphuric acid before further treatment. There is thus a considerable saving in time and a purer product is obtained in the next stage.

A more efficient method has been developed which depends on the filtration of the urine through a filter bed containing silver chloride on a support of Gooch asbestos. One gram of Gooch asbestos is evenly dispersed in 100 ml. of water containing 0·1 gm. silver nitrate and acidified with sulphuric acid. The silver chloride is precipitated by adding a slight excess of chloride with constant stirring. On a sintered glass filter (diameter 40 mm., porosity 3), a layer of plain asbestos is formed and drained but without sucking air through. The filter is then tilted on its side while the silver chloride suspension is carefully added. This is then drained without drawing air through it. The moist silver chloride is then covered with a layer of dry acid-washed sand, which is allowed to fall gently on to the silver chloride until a uniform cover is obtained. The addition of this layer is necessary to prevent the silver chloride from shrinking away from the side of the filter during subsequent operations. A small disk of filter paper is placed on top of the sand to prevent disturbance of the layers when solutions are being poured on to the filter. The finished filter is washed with 0·1 *N* sulphuric acid. Such a filter is suitable for processing 2 litres of urine. Prepared filters can be stored if protected from drying and from the action of light.

The urine to be treated is acidified to *p*H 5 and heated to 95° C. to remove dissolved gases. If not absolutely clear, the urine should now be filtered through paper. The urine is cooled to about 50° C. and further sulphuric acid added to a final concentration of 0·1 *N*. It is then filtered through the silver chloride filter at a rate of about 100 ml. per minute, care being taken to stop the suction before the filter is sucked dry. The filter is then washed with 200 ml. of 0·1 *N* sulphuric acid.

The iodide of the urine is retained in the filter and is recovered in the form of iodic acid by passing 50 ml. of chlorine water containing 0·1 *N* sulphuric acid through the filter. Most of the radioactive iodine appears in the first 25 ml. passed through the filter. The excess chlorine is removed from the filtrate by distilling in all-glass apparatus, the distillation being stopped when about 5 ml. of distillate has formed or when radioactivity begins to appear in appreciable amounts in the distillate. The iodic acid is reduced by the addition of 10 mgm. of potassium metabisulphite and the solution is then neutralized with sodium carbonate. The resultant solution, about 45 ml. in volume, is free of odour and unpleasant taste and after standardization can be administered to the patient without further treatment. It may also be noted that the chlorine treatment regenerates the silver chloride filter, which may be used again after washing with dilute sulphuric acid. Success depends on the addition of sulphuric acid to the extent of 0·1 *N* to all solutions passed through the filter to prevent the silver halides becoming partly colloidal, and on preventing the formation of air bubbles in the filter bed, for these cause channelling of the solutions. For this reason the filter beds must never be sucked quite dry, and the urine and the wash solutions should be heated and cooled before passing through the filter.

Iodine-131 as received from the Atomic Energy Research Establishment, Harwell, and the urine of patients receiving such iodine contain 2–10 per cent of iodine, presumably in organic combination, which is not removed by filtration through silver chloride. Such organic iodine-131 is not removed if the filtrate with added carrier is passed through a second silver chloride filter. The removal of iodine-131 in the form of iodide from urine is 99 per cent complete. Recovery of iodine-131 from the filter by chlorine water leaves 2–8 per cent of the radioactivity in the filter.

A recovery experiment with 1 litre of urine containing 11·46 mC. of iodine-131 gave the following results. Distribution of the radioactivity was:

Retained in the first filter, 0·05 per cent.
Unabsorbed by the silver chloride, 1·25 per cent.
In the washings from the silver chloride, 0·05 per cent.
Remaining in the silver chloride after chlorine treatment, 2·18 per cent.
In the distillate when removing the excess chlorine, nil.
Total losses, 3·53 per cent.
Recovery, 96·47 per cent = 11·06 mC.

Recovery and standardization of the recovered iodine-131 were completed within two hours. In other experiments with urine from the same patient, greater losses were experienced. 2·6 per cent was lost in the urine filtrate and as much as 7·4 per cent was retained in the silver chloride after chlorine

treatment. The average recovery in three experiments was 91 per cent.

The advantages of this method are the good degree of purity and concentration of the final product and the short time required for the process, with subsequent reduction in radiation hazards. With the filters and solutions prepared in advance, the iodine-131 in a 24-hr. urine specimen can be recovered in less than two hours.

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A Rapid Routine Method for the Estimation of Nicotine in Tobacco

THE nicotine content of tobacco varies between wide limits, depending on the species studied. With the view of estimating the nicotine content in tobacco species grown in India, particularly in those of low nicotine content obtained in grafting experiments, a rapid semi-micro method of distillation followed by a spectrophotometric method of estimation have been developed.

Nicotine is distilled by a modification of Griffith and Jeffrey's method[1], wherein soda-lime is used instead of magnesium oxide. 0·5 gm. of powdered and sampled tobacco (cured) is taken, and the nicotine liberated in five minutes by superheated steam under pressure in the presence of soda-lime is collected in dilute hydrochloric acid and made up to a known volume. An aliquot of the solution appropriately diluted to fall within the range of Beer's law is taken for spectrographic analysis. The characteristic absorption band of nicotine in acidified water at 2590 A. region is recorded with a Spekker ultra-violet photometer and an intermediate quartz spectrograph. The specific extinction coefficient defined as spectral density referred to a cell-depth of 1 cm. and concentration of 1 gm. per litre of nicotine solution at 2590 A. was found to be 34·5, as against 34·3 obtained by Willits *et al.*[2]. However, in the samples of tobacco studied, no background correction as suggested by the earlier investigators was found necessary. Hence the extinction values recorded at 2590 A. could be used directly for the calculation of the nicotine content in the sample.

The extinction coefficient was found to be independent of the strength of acid used (N/5–N/80 hydrochloric acid), the values obtained for a sample varying only between 0·55 and 0·56. The results obtained by this method and the standard A.O.A.C. method agreed very closely. When compared with the A.O.A.C. method, which takes 24–48 hr., this method gives results well within an hour, the error not exceeding ± 2·5 per cent on the nicotine content present in the sample studied. With this technique, it is possible to estimate nicotine down to 1 p.p.m. in solution. Almost all the nicotine in a sample, irrespective of the total amount present, could be recovered in about five minutes by this semi-micro method. For longer times of distillation studied, the variations in the nicotine recoveries are small and are within the experimental errors.

COMPARISON OF THE SEMI-MICRO AND THE STANDARD METHODS OF DISTILLATION

Sample No.	Nicotine content (per cent) Semi-micro method	Standard method
1	3·86	3·86
2	4·14	4·16
3	4·05	4·09
4	3·91	4·10
5	4·14	4·10
6	3·19	3·19
7	3·66	3·89
8	3·24	3·24

The spectrophotometric estimation of the recoveries of nicotine for different samples of tobacco, both by the semi-micro and standard methods of distillation, are shown in the accompanying table.

It can be seen that there is a fairly good agreement between the two methods of distillation studied. Thus a combination of the semi-micro method of distillation and the spectrophotometric method of estimation provides a rapid and reliable technique for the routine estimation of nicotine in tobaccos. Further details of the method will be published elsewhere.

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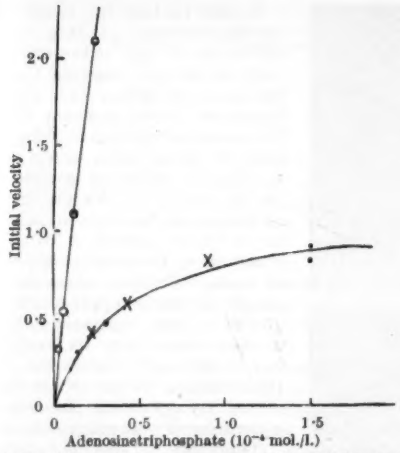
Effect of Adenosine Triphosphate on the Light-Scattering of Actomyosin Solution

IT is well known that the viscosity[1], the double refraction of flow[2] and the light-scattering[3] of actomyosin solution are changed by the addition of adenosine triphosphate. Many investigators have shown that the course of the viscosity change can be divided into three phases[4]: the viscosity of actomyosin solution drops rapidly after the addition of adenosine triphosphate (first phase), reaches a constant value (second phase) and then recovers gradually (third phase). But the measurement of viscosity is not considered to be suitable for the kinetic analysis of these changes, because it takes twenty to thirty seconds for each determination, while the whole change is completed within a few minutes. Therefore theories hitherto suggested for explaining the mechanisms of these phenomena have little experimental support.

We have succeeded in measuring the change of the intensity of the scattered light due to actomyosin solution upon the addition of adenosine triphosphate. The measurements were carried out with an electron multiplier–electromagnetic oscillograph (or μ-amperemeter) system.

The actomyosin used was a purified 'myosin B'[1], prepared from the hind-leg muscle of rabbits. Adenosine triphosphate extracted from acetone-dried rabbit muscle was isolated by Kerr's method[5] and was used as the sodium salt; the measurements were carried out at *p*H 6·4, at 20° C. and in 0·5 *M* potassium chloride.

First phase. The intensity of light-scattering of actomyosin solution decreases rapidly after the



Effect of calcium and magnesium ions on the initial velocity of the phase I.
o = 1/100 mol./l. $MgCl_2$; × = 1/150 mol./l. $CaCl_2$; ● = control

addition of adenosine triphosphate. In the absence of magnesium ions, the rate of decrease is proportional to concentration of adenosine triphosphate as long as the latter is low. But in the presence of magnesium ions, the initial rate of decrease is proportional to concentration of adenosine triphosphate over the whole range of concentrations investigated. Calcium ions have no influence upon the system in the first phase.

Therefore the mechanism of the first step may be as follows:

$$M + \text{ATP} \xrightarrow{k_1} M\cdot\text{ATP}$$
$$M\cdot\text{ATP} \xrightarrow{k_2} M'\cdot\text{ATP},$$

where M and M' indicate respectively the original molecule and deformed molecule of actomyosin. The velocity constants of each reaction step are shown in the accompanying table.

VELOCITY CONSTANTS

	Without addition	Ca++	Mg++
k_1 (1/sec.)	3×10^4	3×10^4	$10{\cdot}2 \times 10^4$
k_2 (1/sec.)	1·0	1·0	$\geqslant$ 5·0
k_3 (1/sec.)	1/40	1/30	1/30

Second phase. As pointed out by Csapó[6], the duration of the second phase is proportional to the amount of adenosine triphosphate added and is in reverse proportion to the activity of adenosine triphosphatase.

Third phase. When adenosine triphosphate is split to a certain extent, the light-scattering intensity of actomyosin solution recovers gradually to the original value. With the exception of the first few seconds in the third phase, when a small amount of adenosine triphosphate may still remain, the velocity of recovery obeys the formula for a first-order reaction and is independent of the initial concentration of adenosine triphosphate added. It is slightly affected by calcium as well as magnesium ions. The velocity constant k_3 of this reaction:

$$M'\cdot\text{ATP} \xrightarrow{k_3} M + \text{ATP}$$

measured under various conditions is shown in the table.

Details of these experiments and the relation of light-scattering to adenosine triphosphatase activity will be published later in the *Journal of Biochemistry*.

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The Cholinesterase of Cholinergic Sweat Glands

FURTHER studies of the cholinesterase present in the sweat glands of the pad of the cat's foot[1] have shown that the pattern of response of this enzyme is not identical with that of other tissue cholinesterases.

The examination for cholinesterases was carried out by the histochemical method developed by Koelle[2], and evidence has already been presented[1] that on the basis of differential inhibition with di*iso*propyl fluorophosphonate, by means of which specific cholinesterase can be demonstrated in this method, the cholinesterase of the sweat glands of the cat appeared to be of the 'pseudo' type. This histochemical method is open to certain objections. If, however, it is used in a purely comparative and non-quantitative way, the interpretations of the results so obtained are simplified and seem to be valid.

The substrate for the demonstration of all cholinesterases is acetyl thiocholine[2], and differentiation between specific and other cholinesterases is based on the observation (made by means of manometric studies on tissue homogenates) that, whereas incubation with 10^{-6} *M* di*iso*propyl fluorophosphonate for 30 min. inhibits 'non-specific' or 'pseudo' activity of both plasma and brain homogenates of the cat completely, that of the 'specific' or 'true' activity is inhibited by only approximately 40 per cent.

On the other hand, specific cholinesterase does not hydrolyse butyryl thiocholine, whereas non-specific cholinesterase splits this substance more rapidly than it does acetyl thiocholine. This characteristic is therefore utilized in the histochemical localization of this enzyme.

Results obtained are shown in the accompanying photomicrographs. Fig. 1 shows the appearance of a sagittal section of the hairless pad of the cat's fore-foot stained to show all cholinesterases. Fig. 2 shows the appearance of a similar section stained for specific cholinesterase. These observations seemed to indicate clearly, although in a negative way, that all the cholinesterase activity present must be due to an enzyme or enzymes of the 'pseudo' or 'non-specific' group.

When the tissue was examined for non-specific cholinesterase using butyryl thiocholine as substrate, however, it was found (Fig. 3) that whereas a satisfactory hydrolysis could be obtained in 15 min. at 37° C. with acetyl thiocholine, not less than 150 min. was required for the hydrolysis of butyryl thiocholine. It is evident, therefore, that the pattern of response

obtainable by this method is identical neither with that of the true nor with that of pseudo-cholinesterase.

In this connexion it is significant that Ord and Thompson[3] have found, with a partially purified soluble cholinesterase from rat's heart, that the high rate of hydrolysis of propionylcholine by this enzyme indicates that there is a cholinesterase which belongs neither to the aceto-cholinesterase nor to the butyro-cholinesterase types described by Sturge and Whittaker[4].

Although the histochemical method revealed a close association of cholinesterase with the sweat glands, it was not possible to locate more specifically the site of this enzyme with this method alone. In order to achieve this, it was thought that denervation of the glands might cause the cholinesterase of the nerve fibres to disappear, thus rendering a clearer picture. Accordingly, the stellate ganglion on one side only of a cat was removed. After twenty-one days, the central pad of the fore-foot on the same side was examined. The result when sections were stained for all cholinesterases is shown in Fig. 4; there is a virtually complete disappearance of the enzyme.

It seems evident, therefore, that the enzyme which can be demonstrated in normal sections from the central pad is associated mainly with the nervous side of the neuro-effector system of the sweat glands.

It has been tacitly assumed that there are no differences between parasympathetic and post-ganglionic cholinergic sympathetic nerve fibres other than those of origin and distribution and, since neither functionally nor histologically has it been possible to differentiate between them, this assumption seemed justified. The present experiments have shown, however, that the cholinesterase of the sympathetic nerves of the sweat glands is not of the specific type found in all other nerves seen so far, and experiments now in hand will show whether this difference extends also to post-ganglionic parasympathetic fibres.

It may be that the sweat glands are exceptional in this enzymic difference of their nerve supply, as they are in not obeying Cannon's law of denervation[5], for example. Moreover, there appears also[6] to be in man a time-lag in the appearance of sweat when acetyl-choline is injected which is greater than can be accounted for on the basis of diffusion. In contrast, when the nerve to the gland is stimulated, there is an immediate appearance of sweat. Further, when the post-ganglionic nerve supply to the sweat glands in man degenerates, there is a loss of sensitivity to acetyl-choline[7]; although Burn[8] has shown that there is in the cat no loss of sensitivity to pilocarpine after degeneration of post-ganglionic nerves.

There are, of course, specificity differences of cholinesterase from one species to another; but in view of the foregoing it seems highly desirable that the transmitter in this case should be chemically isolated and characterized.

These studies have been made possible through the kindness of Drs. F. Bergel and A. L. Morrison (Messrs. Roche Products, Ltd.), who supplied the thiocholines; and of Prof. J. H. Burn and Miss Judith Robinson (Department of Pharmacology, Oxford), who supplied the sympathectomized cats. I am also indebted to Dr. F. A. Denz, of the Medical Research Council Unit, Carshalton, and Dr. V. P. Whittaker, Department of Biochemistry, Oxford, for very helpful discussions.

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Isolation of Hyaluronic Acid by means of Buffered Trichloroacetic Acid Solutions

Investigating the isolation of hyaluronic acid from human tissues, we were faced with the problem of developing a method of isolation better suited to our purposes than the cumbersome methods applied hitherto[1].

It was shown by Rona and Eweyck[2] and Ostern and Hubl[3] that glycogen can be extracted in nearly pure form by trichloroacetic acid from minced tissues. Our method consists essentially in extracting the minced fresh or, better, dried (40° C.; *in vacuo*: thin layer) defatted tissue with trichloroacetic acid solutions (4–10 per cent) at different *p*H values, buffered by adding appropriate amounts of acetate

Prep.	Material	Extract, 4% trichloroacetic acid *p*H	% N	Biuret reaction	Glucuronic acid	Viscosity*	Depolymerization*
A7	dried	4·0	3·4	neg.	pos.	186	10 min.
A8	fresh	4·0	3·6	neg. faintly	pos.	246	12 min.
A14	fresh	4·0	4·1	pos.	pos.	145	11·5 min.
A15	dried	1·0	3·7	neg.	pos.	150	10 min.

* Viscosity and depolymerization measurements were performed according to the method described by Pantlitschko and Kaiser (ref. 4) (McIlvaine buffer *p*H 7·0 + 0·35 per cent sodium chloride; substrate concentration 0·1 per cent). Depolymerization is indicated by the time in minutes to reach half the initial viscosity. Viscosities given are relative viscosities × 100 against the same solution without substrate. We are indebted for a hyaluronidase preparation to the Vister Corp. Casatenovo (Como, Italy).

ion or other bases. The extraction is performed at room temperature with constant stirring (some hours) or at low temperatures (ice box, one to three days) and precipitation with ethyl alcohol. Whether dialysis of the extract is necessary or not depends on the character of the tissue extracted and on the desired purity of the substance to be obtained.

If desired, it is possible to fractionate the substances by different concentrations of alcohol from buffered solutions in water. Comparatively pure preparations of nucleic acid may also be obtained by this method.

Typical preparations from human umbilical cords of hyaluronic acid obtained without any further purification have the properties shown in the accompanying table.

The exact characterization and analytical figures (electrophoresis, content of sulphurated polysaccharides, amino-acids, etc.) of the preparations will be published elsewhere *in extenso*.

As the method described is a comparatively simple one and can be applied not only to the preparation of hyaluronic acid but also to other similar non-protein tissue constituents (such as heparine), the present preliminary report seems to be justified.

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Attempt to prepare Anti-Tyrosine Decarboxylase

In the course of studies on various anti-enzymes, an attempt was made to prepare an anti-tyrosine decarboxylase. The enzyme was an extract from acetone-dried cells of *Streptococcus fæcalis*, prepared and tested by the method of Epps[1]. This extract was injected intravenously into a rabbit at three- to four-day intervals, and antiserum removed seven days (approximately) after the third and subsequent injections. On incubation with the crude enzyme preparation, the antiserum regularly gave a precipitate; but, on removal of this precipitate, enzymic activity was retained or slightly increased. The enzyme had, therefore, neither been precipitated nor inactivated in the supernatant. Precipitates were not obtained when the antiserum was replaced by a non-specific rabbit serum.

Attention should be directed to the fact that the most reliable results were obtained at *p*H 5·5, the optimal *p*H for the enzyme. This is a region in which non-specific precipitation of γ-globulins, and therefore probably of antibodies, might occur, though it is doubtful whether an anti-enzyme if present would be completely precipitated in this way without having any influence on the enzyme.

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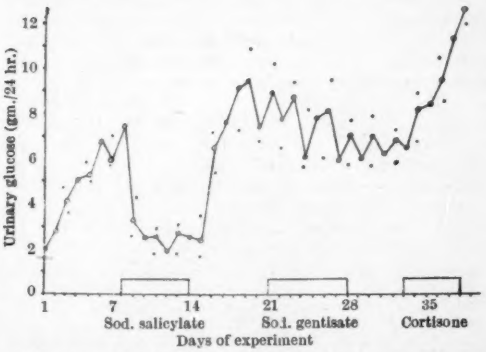
Salicylates and Carbohydrate Metabolism

A number of workers[1] have reported that the administration of salicylates prevents diabetic glycosuria in man, and Ingle[2] has shown that aspirin reduces the glycosuria of rats made mildly diabetic by reason of partial pancreatectomy. We have confirmed this latter effect using rats made severely diabetic with alloxan and found that the closely related gentisic acid (2 : 5-dihydroxybenzoic acid) caused no alteration of the glycosuria, whereas cortisone exacerbated it (see diagram).



Mean 24-hr. urinary glucose and range for a group of 8 alloxan-diabetic rats.
Sodium salicylate: 100 mgm. in 1 ml. arachis oil daily; sodium gentisate: 100 mgm. in 1 ml. arachis oil daily; cortisone: 10 mgm. as saline suspension of cortone acetate (Merck) daily

The effect of salicylates on the blood glucose of fasting alloxan-diabetic rats was then investigated in two groups of animals. Blood glucose was measured by the method of Nelson[3] in each animal at 0, 4, 7 and 24 hr., one group of rats having been given salicylates at 0 hr. The results are shown in Table 1.

These results show that there was no significant difference between the two groups at the start of the experiment, but that a significant fall in blood glucose occurred in alloxan-diabetic animals treated with salicylate, and this fall was significantly different

Table 1. Effect of Salicylates on the Blood Glucose of Fasting Alloxan-Diabetic Rats

Time of estimation (hr.)	Blood glucose (mgm. per 100 ml.) with standard deviations: A. Salicylated	No. of rats	B. Control	No. of rats	For Groups A and B: n	T	P
0	572±133	6	509± 88	5	9	1·0330	0·3
4	355± 48	6	574±118	5	9	4·2135	0·01
7	273±124	6	615± 52	5	9	5·7098	0·001
24	155± 91	3	434±134	5	6	3·2998	0·02

Within Group A for: 0 and 4 hr. $n = 5$, $T = 5{\cdot}0348$, $P = 0{\cdot}01$.
0 and 7 hr. $n = 5$, $T = 6{\cdot}0080$, $P = 0{\cdot}01$.
0 and 24 hr. $n = 2$, $T = 3{\cdot}1923$, $P = (0{\cdot}1)\ 0{\cdot}05$.

from any deviations observed in the control diabetic animals.

Twenty-two rats with alloxan-diabetes of comparable severity were divided into four groups of 5, 6, 5 and 6 animals, the mean blood glucose of each group being between 450 and 500 mgm. per 100 ml. The glycogen content of liver was estimated by the method of Good, Kramer and Somogyi[4] at 0, 4, 7 and 24 hr. after the administration of salicylates. The results are shown in Table 2; determinations of blood glucose were made immediately before killing and showed a similar result to the previous experiment.

Table 2. Effect of Salicylates on the Liver Glycogen of Alloxan-Diabetic Rats

Group	No. of rats	Time of sacrifice (hr.)	Liver glycogen content (gm./100 gm. wet wt.) with standard deviation
1	5	0	1·04 ± 0·83
2	6	4	0·67 ± 0·52
3	5	7	0·64 ± 0·32
4	6	24	0·76 ± 0·72

Comparison of these results showed that at no point is a value of P less than 0·3 obtained, and therefore it is concluded that no significant alteration in liver glycogen occurred despite the fall in blood glucose. The mechanism of these effects is being investigated, and full details of the experiments described above will be published elsewhere.

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Soluble and Available Nitrogen in Manurial Composts

In bulky organic manures and composts, the nitrogen available for plant growth depends partly on the carbon – nitrogen ratio of the material and partly on the nature of the carbon and nitrogen compounds present[1]. Several authors[2] have found, however, a close correlation between available and water-soluble nitrogen in certain organic manures.

We have investigated some of the factors affecting changes in 'water-soluble' nitrogen in composts prepared from waste materials. The experiments extended in some cases up to two years and included estimation of the availability of nitrogen by nitrification tests and recovery-experiments with crops. The composts were mostly prepared in small brick cells and transferred after three to five months to covered storage bins. Full details of the preparation and the materials used will be given elsewhere.

In these experiments, the 'water-soluble' nitrogen was determined by extraction of the sample overnight with cold 0·1 N hydrochloric acid, so as to include absorbed ammonia. Marked changes in this fraction were apparent during composting, and Table 1 shows the behaviour of four composts prepared from wheat straw and sewage sludge.

Table 1. Effect of Level of Nitrogen on Changes in Soluble Nitrogen during Composting

Initial nitrogen (% dry matter)	Soluble nitrogen (mgm./100 gm. dry matter) After 114 days	After 471 days	Soluble nitrogen (% total nitrogen) After 114 days	After 471 days
2·44	161	418	5·9	12·9
1·97	184	337	7·0	11·7
	After 105 days	After 357 days	After 105 days	After 357 days
1·35	101	176	4·9	7·65
1·10	97	107	6·45	5·2

There was no significant increase in soluble nitrogen after composting when the initial level of nitrogen was increased from 1·97 to 2·44 per cent. The compost prepared with a nitrogen content of 1·10 per cent released soluble nitrogen very slowly. Losses of nitrogen during composting indicate that for the production of straw-sludge composts with maximum soluble nitrogen the optimum initial level of nitrogen lies between 1·97 and 1·35 per cent.

When free aeration from below was provided, no significant difference between the level of soluble nitrogen was detected between composts aerated for three weeks and three months respectively.

The nature of the source of nitrogen used to compost straw, however, greatly affected soluble nitrogen, as shown in Table 2, which also illustrates the nearly quantitative nitrification that obtained in mature composts under the conditions of these experiments.

Table 2. Effect of Source of Nitrogen used in Composting Wheat Straw on the Level of Soluble Nitrogen
(Initial per cent nitrogen = 1·63 ± 0·07)

Nitrogen source	Percentage soluble nitrogen after 11 months	Nitrate nitrogen as percentage soluble nitrogen after 11 months
Ammonium sulphate only	36·4	92·3
" " + sludge	17·9	93·4
Sludge only	11·4	93·5

In one experiment in which twenty-three composts were incubated in soil for five weeks in a greenhouse, the equation of the regression line of nitrate formed (Y) on the initial soluble nitrogen (X) was $Y = 1{\cdot}087\,X - 1{\cdot}39$, where X and Y were both expressed as percentages of the total nitrogen. The correlation coefficient, $r = 0{\cdot}942$, was significant at the 0·1 per cent level.

These results emphasize the importance of 'water-soluble' nitrogen during composting, and confirm that the close relation between soluble and available nitrogen found for other organic manures holds also for composts. The relations between soluble nitrogen and the nitrate produced after longer periods of incubation in soil and the nitrogen recovered by

indicator crops will be the subject of later publications.

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Physiological Effects of the Volatile Products of Respiring Potatoes

IT has long been known that the dormancy of potatoes may be prolonged by volatile substances evolved by ripe apples[1]. The active substance may be ethylene, which is evolved by ripe apples[2] and which retards the sprouting of potatoes[3]. Ethylene is also found in the volatile products of bananas[4], avocados[5], pears[6], and various citrus fruits[7]. In view of these observations, it now appears that the physiological effects caused by the accumulation of respiratory products are not necessarily due to the presence of carbon dioxide, though this assumption has been made[8,9]. The prolongation of the dormancy of potatoes is one of the effects which have been attributed to the accumulation of respiratory carbon dioxide[10].

During recent work it has been shown that if the volatile metabolic products of potatoes were allowed to accumulate, the sprouting of potatoes was retarded. If, however, the carbon dioxide alone was allowed to accumulate, but the other volatile products were removed by circulating the atmosphere through 96 per cent sulphuric acid containing 2 per cent w/v silver sulphate, sprouting was stimulated. This effect could possibly have been due to oxygen depletion, though this is improbable. Sprouting was markedly retarded by scrubbing out all the carbon dioxide in the storage atmosphere but allowing the other volatile metabolic products to accumulate. These results are illustrated in the accompanying table. Further work has indicated that two groups of growth-inhibiting volatile substances are evolved by stored potatoes. The members of one group are absorbed in 96 per cent sulphuric acid, which does not, however, absorb the members of the second group. The latter, which may be absorbed in 96 per cent sulphuric acid activated by silver sulphate, are probably olefines and, by analogy with fruit[2], this group may consist almost entirely of ethylene.

EFFECT OF STORAGE ATMOSPHERE UPON THE SPROUTING OF MAJESTIC POTATOES STORED FOR 15 WEEKS AT 10° C.

Storage atmosphere* Carbon dioxide (%)	Oxygen (%)	Volatiles other than carbon dioxide	Wt. of sprouts as % of that of sprouted tubers	Length of storage in exp. atmosphere (days)
5·6–7·3	12·9–14·5	Absent	3·4	76
0·03	20·8	Absent	1·2	95
4·8–7·1	12·9–15·0	Present	0·8	76
0·0	16·8–19·8	Present	0·0	95

* Analysis of air entering the potato containers. In every case the atmosphere was circulated through the containers (holding 31·7–31·8 kgm. potatoes) and the absorbing system at a rate of about 20 litres an hour. The oxygen was replenished as used.

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Bacteriophage Inactivation by Antiphage Serum Diluted in Distilled Water

THE fraction f of bacteriophages remaining active t minutes after having been mixed with antiphage serum may be expressed by the following relation[1]:

$$f = \exp(-kt/D), \qquad (1)$$

in which D represents the dilution of the serum. The rate constant k, therefore, is a measure of the potency of the serum. Usually, k is determined by diluting the serum and the suspension of virus particles in nutrient broth or buffered saline, in which media a good serum may, at 37° C., show a k-value of 500–1,000 per min. Hence, in order to reduce the fraction of surviving virus particles, f, to less than 1 per cent within an hour, such a serum cannot be diluted by more than 10^4.

I have found that nutrient broth and buffered saline must contain factors which inhibit the inactivation of bacteriophages by antiphage serum, as the rate of inactivation can be greatly increased by making the reaction take place in distilled water. Moreover, the interaction of phage with antiphage appears to require the presence of a third factor, since very high dilutions of antiphage serum in distilled water will not cause observable virus inactivation, unless small amounts of normal serum, or of peptone, are added.

Thus, rabbit antiphage serum (showing a k-value of 600, in broth), diluted by a factor of 10^4 in distilled water, can be mixed with a suspension of bacteriophages in distilled water, without the occurrence of observable inactivation. Rapid inactivation, corresponding to a k-value of 100,000 or more, will follow when normal serum at a concentration of 20–1,000 gamma per ml., or peptone at a concentration of 50–2,000 gamma per ml., is added to such a mixture. Higher concentrations of these substances have been found to inhibit the process of inactivation. Concentrations of monovalent ions exceeding about 10^{-2} molar, and of calcium ions exceeding about 10^{-3} molar, were also found to be inhibitive. The general shape of the inactivation curves, when making the reaction proceed in distilled water, is the same

as that observed in nutrient broth[3], showing an exponential decrease, as described by equation (1), down to 10^{-3} or 10^{-4} survivors, followed by a bend.

The effects described have been shown for coliphages *T* 2*r*+, *T* 3 and *T* 4*r*. Further experiments on the inactivation mechanism are now in progress.

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Presence of Trypanosomes in Bush Babies after Eating Infected Rats

Two bush babies (*Galago crassicaudatus lasiotis* Peters), examined six weeks after capture, were found heavily infected with polymorphic trypanosomes. Inquiries elicited that a few weeks earlier they had escaped from their cages at night and eaten the bodies of several white rats killed while infected with a virulent strain of *T. gambiense* and left lying on a bench. As an experiment, another bush baby and a white rat heavily infected with *T. rhodesiense* were placed in the same cage. The rat was immediately seized, killed and eaten by the bush baby, which afterwards became infected. When tested the trypanosomes failed to penetrate mucous membranes, so were presumably transmitted through abrasions; the infections were fatal within a month.

Bush babies are known to be actively carnivorous, and zur Strassen[1] has stated they are very formidable enemies of small animals. Although it is not known whether bush babies can be a reservoir of trypanosomes in Nature, recent work in East Africa implicates them in the jungle yellow fever cycle; it is conceivable the infection could be acquired if rodents or other small animals harbouring the virus were eaten during dry periods when transmission by mosquitoes is interrupted.

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Recombination in *Bact. coli K* 12: Unidirectional Transfer of Genetic Material

The development of nutritionally independent prototroph colonies from mixed cultures of doubly dependent mutant strains of *Bact. coli K* 12 was first demonstrated in 1946[1]. Back mutation to prototrophism did not occur when the mutants were cultured separately. Since the pattern of unselected marker characters in prototrophs was usually different from that in either mutant, the phenomenon was clearly due to genetic recombination. The incompetence in recombination of culture filtrates (unlike type transformation in *Pneumococcus*), and recent evidence for the occasional occurrence of diploid heterozygous prototrophs[2], strongly support the current theory that the genetic transfer is mediated by sexual conjugation. Attempts to reproduce the phenomenon in other strains and species have failed, though successful out-crossing of *K* 12 mutants with a strain of *Bact. acidi lactici* has been reported[3].

In the following experiments, *K* 12 mutants 58–161, requiring biotin and methionine, and *W* 677, requiring leucine, threonine and aneurin, were employed. An attempt was made to investigate the dynamics of recombination by adding streptomycin at intervals to a series of plates of basal medium (plus aneurin) seeded with a mixture of 58–161 and a streptomycin-resistant mutant of *W* 677 (*W* 677/S^r). It was anticipated that the streptomycin would rapidly block the recombination mechanism by inactivating 58–161, while allowing resistant prototroph cells formed prior to its addition to develop into colonies. In practice, the number of prototroph colonies did not differ greatly whether streptomycin was incorporated in the basal medium before plating or was added up to four hours later. Since similar results were obtained when the mutants were mixed for the first time during plating, the occurrence of recombination in mixtures before contact with streptomycin was excluded. Either prototrophs arose before the action of streptomycin on the sensitive mutant became effective, or else those functions of the cell affected by streptomycin were not involved in recombination.

Logarithmic-phase broth cultures of 58–161 were treated with either 1,000 or 2,000 μgm./ml. streptomycin for periods up to 18 hr., under conditions optimal for bactericidal effect. Washed saline concentrates of treated cultures (58–161/S^t), although frequently sterile, invariably stimulated prototroph formation when mixed with *W* 677/S^r on basal medium containing 200 μgm./ml. streptomycin. Whenever streptomycin treatment failed to produce sterility, control reconstruction experiments showed that at least a thousand times as many untreated 58–161 cells as those which had survived treatment were necessary for prototroph formation under similar conditions.

Mixtures of streptomycin-treated *W* 677 (*W* 677/S^t) and 58–161/S^r, on the other hand, invariably failed to produce prototrophs, although comparable recombination-rates were given by the mixtures (*W* 677/S^r + 58–161) and (58–161/S^r + *W* 677). In these experiments streptomycin was not incorporated in the basal medium, since previous analysis of proved prototrophs had shown that about 95 per cent carried the S^r or S^s character of *W* 677. The clear-cut distinction between 58–161/S^t and *W* 677/S^t in ability to participate in recombination was shown to be independent both of the presence of the S^r character in the complementary mutant and of the basal medium environment. Thus (58–161/S^t + *W* 677) produced prototroph colonies on every occasion, whether cultured directly on basal medium or initially on nutrient agar. The mixture (*W* 677/S^t + 58–161), however, failed to do so repeatedly on basal medium and, in a single experiment, when seeded on nutrient agar.

It is unlikely that sensitive cells which have been acted upon for 18 hr. by very high concentrations of streptomycin can still participate in cytoplasmic fusion in the continued presence of the drug. Moreover, if conjugation under these conditions was possible for 58–161/S^t, it might also be assumed for *W* 677/S^t. Yet suspensions of the latter are inactive in recombination. It is more probable that recombination is mediated by genetic elements, extruded by the viable cell, which adhere to the cell wall and which, like viruses, are unaffected by streptomycin.

Thus, the dead cell could serve merely as a passive carrier for its genetic elements after their expulsion. The incompetence of *W* 677/*St* becomes intelligible only if we suppose that the role of *W* 677 is primarily the vital one of accepting genes and incorporating them into its genetic structure.

It is known that symbiotic bacterial viruses can transfer hereditary characters to heterologous strains[4], and that *K* 12 harbours a virus which can be liberated by small doses of ultra-violet light[5]. The known facts of recombination, and especially its marked enhancement by small sub-mutagenic doses of ultra-violet light[6] and the presumptive one-way transfer of the genetic agent from 58–161 to *W* 677, suggest the possibility that this agent may be a virus. The existence of a latent virus in 58–161 has been unmasked by *X*-radiation (personal observation).

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Pubescent Cottons for Egypt

Egypt produces five commercial varieties of cotton, ranging in staple-length between $1\frac{9}{32}$ in. (= 32·8 mm.) and $1\frac{15}{32}$ in. (= 40·8 mm.). This range carries with it a parallel variation in yarn-strength and spinning qualities. All these varieties were released by the Ministry of Agriculture.

Before a variety is released commercially, it must possess some, if not all, of the following qualities: (1) high yield, (2) high ginning out turn, (3) specific spinning qualities corresponding with its class of staple-length, (4) characteristic intrinsic strength of fibre, (5) earliness in maturity, and (6) immunity or at least high resistance to pests.

Other things being equal, all our varieties are high yielders and some give a high percentage of lint after ginning. As for spinning qualities, the reputation and standard of Egyptian cottons are high. Earliness in maturity is perhaps only exhibited by one. Damage caused by fungal pests, particularly the wilt caused by *Fusarium vas-infectum*, has been overcome by a state of complete genetic immunity. Unfortunately none of these varieties possesses natural resistance (hereditary or otherwise) against any of the insect pests of cotton. This causes a considerable loss to the national revenue.

The Plant Breeding Section of the Royal Agricultural Society, however, has in hand at this season at least four or five strains of cotton (not commercially released yet) all of which possess a high degree of resistance against some of the most serious of the insect pests which attack the cotton seedling. The two most important of these are *Aphis gossypii* and *Thrips tabaci*. Even the other classes of insects which attack the later stages of germination have caused considerably less damage. The two most important of these are the cotton leaf worm *Prodenia litura*, and the boll-worms, of which there are two, the spiny boll-worm *Earias insulana* and the pink boll-worm *Platyedra gossypiella*.

All these new strains owe their origin to a single off-type plant which was discovered in a cotton plantation in 1944. This plant was remarkable for its very dense coat of hairs covering all its organs, giving it a beautiful silvery shine. Furthermore, it was very prolific, very early in maturing, and gave a very high ginning out turn. Its spinning qualities, however, were very poor; indeed, they were inferior to the lowest grade of cotton known.

It was thought that should this off-type breed true, it possessed enough merits to warrant its utilization as a parent in crossings with the view of transferring its qualities in a heterozygous F_1, on the segregation of the progenies of which selection could be practised.

All the seed collected from this off-type was sown in 1945, and all the plants produced bred true to type. Indeed, they continued to do so, and we have in 1951 F_7 plants from controlled selfing, quite true to type. We thus have a definite genotype, evidently from a mutation the origin of which is unknown.

In 1945, several crosses were made between this pubescent type and all the commercial varieties. In 1951 we have five families of F_4 plants, all of which show good promise towards our objective.

In 1947, a thorough investigation was made of this type, with the following results:

(1) The habit of growth, branching nature, types of flower, boll and seed, and all such botanical features are typically those of *Gossypium barbadense*, the species to which all Egyptian cottons under cultivation belong. This conclusion is further substantiated by the following findings.

(2) The somatic chromosome complement is typically *G. barbadense*.

(3) Crossing is readily accomplished. Fertility is very high, and the F_1 progeny and advanced generations are similarly fertile without the appearance of any unbalanced types as one gets in interspecific crosses[1].

(4) Meiosis in the pubescent parent, in the commercial varieties, and the F_1 hybrids between them is identical, with preponderance of bivalents and none of the irregularities reported in interspecific hybrids[2,3].

(5) Pubescence is dominant and inherited on a simple Mendelian basis.

(6) There is some correlation between the pubescent habit on one hand and high yield, high ginning out turn and earliness on the other hand. It is very suggestive of linkage. Fortunately the poor lint qualities are not linked with them, as they were separated in later generations.

(7) All pubescent progenies showed extreme resistance against aphis and thrips[4], and escaped a good deal of the damage caused by the cotton leaf and boll-worms.

More crosses were initiated in 1947, and these enabled us to embark on a scheme of backcrossing on the F_1 plants sown in 1948. From these 1947 crosses we thus have in hand in 1951: (*a*) ordinary F_4 families, and (*b*) other families in their third generation of backcrossing, using the commercial varieties as the recurrent parent on selections of pubescent segregants. The object is to recover the commercial type of lint with the added pubescent nature and all that is linked with it.

In conclusion, we possess from these and the 1945 crosses a choice of four or five strains with excellent agronomic characteristics, and their pubescent nature gives them a clear botanical distinction as the first of their kind in Egypt. It is expected that in a few

years time their homozygosity will be such that they can be released as commercial varieties of much improved qualities.

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Systemic Insecticides and the Mealybug Vectors of Swollen-Shoot Virus of Cacao

During the summer of 1949, samples of bis (bis-dimethylamino) phosphonous anhydride and bis (dimethylamino) fluorophosphine oxide prepared by Dr. B. A. Kilby, of the School of Medicine, Leeds, were received through Dr. R. A. E. Galley, of the Agricultural Research Council.

The chemicals were added to normal NPK culture solutions and their action tested against three common mealybug vectors of the virus disease known as 'swollen shoot of cacao'. The mealybugs used were *Pseudococcus citri* (Risso), *P. njalensis* Laing and *Ferrisia virgata* (Ckll.)[1]. With the first species naturally infested cacao seedlings were available; but artificial infestations by the other two species had to be made. These artificial infestations were successful, and healthy mealybug colonies became established on the test plants.

In the first series of tests, the chemicals were added to the nutrient solutions so that the final concentrations were 10, 50 and 100 parts per million. Five plants were used for each species at each concentration. Afterwards, 200 and 500 p.p.m. were also tried using natural infestations of *P. citri* as the test insects. Ten test plants were used at these higher concentrations. Similar numbers of untreated control plants were kept for each series.

The solutions were aerated at regular intervals and kept at the original volume by the addition of distilled water. During the eight-week course of the tests the plants generally flourished and, except for the phytotoxic effects mentioned later, their growth can be accepted as normal. It was thought that the presence of extra phosphorus might have a stimulating action, but a statistical analysis of the seedling heights in the first series before and after the test showed no significant gain or loss over the control plants.

Bis (bis-dimethylamino) phosphonous anhydride. Under the conditions of the experiment, this chemical was not successful in controlling the species tested at concentrations up to 100 p.p.m. At 200 p.p.m. apparently healthy colonies of *P. citri* were still active after eight weeks on nine of the ten test plants, although their numbers were markedly lower than those of the untreated control. At a concentration of 500 p.p.m. no mealybugs were found on four of the ten test plants, and the numbers on the others were very small indeed.

Bis (dimethylamino) fluorophosphine oxide. This chemical rapidly showed signs of being effective at 10, 50 and 100 p.p.m., and even at the lowest concentration a reduction in numbers of all three species became evident after two weeks. The time for complete control varied from two to six weeks except in the case of *P. citri* at 10 p.p.m., when the insects, which had reached very low numbers at the end of five weeks, showed a slight increase at the end of eight.

At the 200- and 500-p.p.m. levels, the oxide showed definite phytotoxic action. This entirely upset the experiment and the mortality figures for the mealybugs were rejected as being unreliable.

My thanks are due to Drs. Kilby and Galley for their assistance in making these preliminary experiments possible.

John Nicol

West African Cacao Research Institute,
Tafo, Gold Coast.
Aug. 29.

[1] Box, H., *Nature*, **155**, 608 (1945).

The Lotmar–Picken X-Ray Diagram of Dried Muscle

Owing to a number of unforeseen circumstances, mostly beyond our control, an incorrect version of part of our communication under the above title was printed in *Nature* of December 22, 1951. Our main conclusion, that a fibre repeat of 5·3–5·4 A. is in better agreement with the original Lotmar–Picken diagram than the value 5·65 A. given by Lotmar and Picken, was stated correctly and was deduced from the χ-values of the reflexions on the first layer line.

The majority of these reflexions listed by Lotmar and Picken and by Herzog and Jancke can be indexed satisfactorily in terms of a unit cell similar to that of Lotmar and Picken, but with $b = 5{\cdot}3$ A. This is indicated in the accompanying table, in which the calculated spacings are those for a monoclinic cell with $a = 11{\cdot}70$ A., $b = 5{\cdot}30$ A., $c = 9{\cdot}85$ A., $\beta = 73° 30'$. This table and unit cell should replace those given in the original letter.

Observed and Calculated *d*-Values

	Herzog and Jancke	Lotmar and Picken	Calculated
Meridian	5·33	—	5·30 (010)
1st layer line	4·90	4·80 (I_1)	4·80 (110)
	4·67		4·64 (011)
		4·27 (I_2)	4·09 (11$\bar{1}$)
		3·97 (I_3)	3·86 (210)
		3·62 (I_4)	3·60 (112)
	3·47		3·52 (012)
	3·10		3·12 (311)
		2·72 (I_5)	2·71 (013)
		2·51 (I_6)	2·51 (313)
		2·45 (I_7)	2·47 (412)

The only serious discrepancies are those between the observed and calculated values of I_2 and I_3; these may be within the limits of accuracy of the measurements. The calculated density, assuming four amino-acid residues in the unit cell, has the reasonable value 1·30 gm./c.c.

As mentioned in our previous communication, the α-helix of Pauling and Corey will require compression to reduce its pitch to about 5·3 A. if it is to be compatible with these results (assuming the latter apply to the fibrous proteins). This might introduce difficulties, for example, by producing improbably short hydrogen bonds and, further, the axial translation per amino-acid residue will be reduced to 1·47 A.

C. H. Bamford
W. E. Hanby

Research Laboratory,
Courtaulds, Ltd.,
Maidenhead, Berks.
Dec. 19.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 21

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Implications of the Railway Electrification Committee's Report, 1950" (to be opened by Mr. C. M. Cock).

UNIVERSITY OF LONDON (in the Electrical Engineering Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. G. Millington: "Radio Wave Propagation".* (Further Lectures on January 28, February 4 and 11.)

Tuesday, January 22

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. N. H. de V. Heathcote: "Early Experiments on the Conduction of Electricity".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. W. Parnell: "Recording Human Constitution".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS AND SUPPLY SECTIONS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "High-Voltage Measurements and Tests" (to be opened by Dr. J. S. Forrest and Dr. H. Tropper).

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. E. A. Newman: "Storage in Computors".

BRITISH ORNITHOLOGISTS' UNION (joint meeting with the BRITISH TRUST FOR ORNITHOLOGY, at the Zoological Society of London, Regent's Park, London, N.W.8), at 6 p.m.—Mr. J. A. Gibb: "Feeding Behaviour of the Rock Pipit and an Attempt to Measure its Daily Food Intake".

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. P. M. S. Blackett, F.R.S.: "Navigation—from Columbus to Newton".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. P. H. Southwell: "Aircraft in Agriculture".

Wednesday, January 23

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Dr. P. F. R. Venables: "Some Impressions of American Technical Education".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Essentials of a First Course in Electricity and Magnetism" (to be opened by Mr. H. Kayser).

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—General Discussion on "Microscopy" (to be opened by Mr. J. D. Hannah).

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the NUTRITION PANEL of the FOOD GROUP and the OILS AND FATS GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. Wilkinson: "The Digestibility of Fat".

Thursday, January 24

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Arkell: "The Early Dynasties of Ancient Egypt".*

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Prof. G. E. Blackman: "Oil Seed Crops in Temperate Climates".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. E. B. Edney: "The Woodlice of Great Britain and Ireland".

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. G. Herzberg: "Rotation-Vibration Spectra and Structure of Polyatomic Molecules".* (Further Lectures on January 30 and February 1.)

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. W. E. Garner, F.R.S.: The 'Gustav Tamann' Memorial Lecture.

Friday, January 25

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4 p.m.—Geophysical Discussion on "Thunderbolts—The Electric Phenomena of Thunderstorms" (Speakers: Dr. T. W. Wormell, Dr. R. H. Golde and Dr. F. J. Scrase).

ROYAL INSTITUTE OF PHILOSOPHY (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Prof. H. D. Lewis: "Philosophy and Theology".*

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. C. A. Coulson, F.R.S.: "The Contributions of Wave Mechanics to Chemistry" (Bedson Club Lecture). (All Fellows are invited.)

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. Holmes Fletcher: "The Marine Gas Turbine from the Viewpoint of an Aeronautical Engineer".

MANCHESTER STATISTICAL SOCIETY, STATISTICAL METHODS STUDY GROUP (at the Albert Hall, Peter Street, Manchester), at 5.30 p.m.—Miss N. Goodman: "Some Recent Investigations in Medical Statistics".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. J. L. Kent: "Estimation of Ship's Engine Power from Model Experiment Results".

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. P. A. T. Bevan: "The Planning and Development of Television Broadcasting Stations".

WOLVERHAMPTON SOCIETY OF APPLIED SCIENCE (at the Technical College, Wolverhampton), at 7.30 p.m.—Mr. A. L. Whitwell: "The Use of Electronics in Aircraft Design".

Saturday, January 26

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, NORTH OF ENGLAND SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Annual General Meeting; Mr. A. L. Bacharach: "The Use of Laboratory Animals as Analytical Reagents".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Miss Sona Rosa Burstein: "Medical Belief and Practice among Primitive Peoples in the Modern World".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMICAL ENGINEERS (with a first- or second-class honours degree in chemical engineering or in chemistry with a postgraduate course in chemical engineering, or equivalent qualification) (Senior Scientific Officer grade) at a Ministry of Supply Research and Development Establishment in South-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.953/51A (January 26).

LECTURER IN MINE SURVEYING AND DRAWING, at the Ashington County Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (January 26).

GRADUATE BIOCHEMIST in the Group Pathological Laboratory—The Group Pathologist, Kingston Hospital Pathological Laboratory, 37 Coombe Road, Kingston, Surrey (January 28).

PLANT PHYSIOLOGIST (with a good honours degree and special knowledge and experience of plant physiology)—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (January 28).

ASSISTANT ELECTRICAL ENGINEERS (general electrical engineering), an ASSISTANT ELECTRICAL ENGINEER (with electronics experience), ASSISTANT MECHANICAL ENGINEERS (with knowledge of turbines or boiler plants, pipe lines, structural engineering, machine tools, welding, or ferrous and non-ferrous materials), an ASSISTANT ENGINEER (with knowledge of motor transport), an ASSISTANT ENGINEER (with knowledge of printing machines), an ASSISTANT INSPECTING OFFICER (with knowledge of scientific instruments and accessories), and an ASSISTANT INSPECTING OFFICER (with knowledge of chemistry, timber, wood products, etc.)—S. B. Branch, India Store Department, 32–34 Edgware Road, London, W.2, stating post applied for (January 31).

FLAME RADIATION BRITISH COMMITTEE BURSARY for one year at Stockholm Technical College, to take part in a series of fundamental experiments investigating the mechanism of flame radiation in a large-scale combustion chamber—Prof. O. A. Saunders, City and Guilds College, Exhibition Road, London, S.W.7 (January 31).

HEAD OF THE TEXTILE DEPARTMENT, Rochdale Municipal Technical College—The Chief Education Officer, Education Office, Fleece Street, Rochdale (January 31).

LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, The University, Bristol 8 (January 31).

PRINCIPAL OF THE BUCKHAVEN MINING AND TECHNICAL SCHOOL—The Director of Education, County Offices, Wemyssfield, Kirkcaldy (January 31).

SCIENTIST, Grade II (with an honours degree, or equivalent qualification, and research experience in physics (fundamental or applied), electronics or engineering)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/412 (February 2).

FELLOWSHIPS IN EDUCATIONAL PSYCHOLOGY—The National Association for Mental Health, 39 Queen Anne Street, London, W.1 (February 6).

FELLOWSHIPS AND SCHOLARSHIPS for Session 1952 at Ankara—The Secretary, British Institute of Archæology at Ankara, 56 Queen Anne Street, London, W.1 (February 20).

PHYSICAL CHEMIST to take part in an investigation of large molecules of biological origin—The House Governor, Chester Beatty Research Institute, Royal Cancer Hospital, Fulham Road, London, S.W.3 (February 25).

PROFESSIONAL ENGINEERS, General Service Class (main and senior grades) in the Admiralty, for the production of mechanical, electrical and electronic equipment of H.M. ships, etc.—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting S.86/51 (February 29).

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (March 1).

MARY SOMERVILLE RESEARCH FELLOWSHIP—The Secretary, Somerville College, Oxford (March 4).

ASSISTANT DRAINAGE ENGINEERS in the Ministry of Agriculture and Fisheries, to deal principally with schemes in connexion with land drainage, water supply and coast protection—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3405 (March 31).

I.C.I. Research Fellowships in physics, chemistry, engineering, metallurgy, pharmacology, chemotherapy, or any related subject—The Registrar, The University, Liverpool (March 31).

John Murray Travelling Studentship in Oceanography and Limnology—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (March 31).

I.C.I. Research Fellowships in bacteriology, biochemistry, biomolecular structure, botany (plant biochemistry), chemical engineering, chemistry, chemistry of leather manufacture, chemotherapy, colour chemistry and dyeing, engineering (civil, electrical or mechanical), fuel and refractories, geology (including geochemistry), metallurgy, mining (selective flotation and geophysical surveying), pharmacology, physics, physiology, or textile industries (protein chemistry)—The Registrar, The University, Leeds 2 (April 30).

I.C.I. Research Fellowships in chemistry, physics and allied subjects—The Registrar, The University, Manchester 13 (April 30).

Turner and Newall Research Fellowship in engineering, inorganic chemistry or physics, or other allied science—The Registrar, The University, Leeds 2 (April 30).

Foulerton Research Fellowship in Medicine—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (May 1).

Aeronautical and Mechanical Engineers (with first- or second-class honours degree in aeronautical or mechanical engineering, or equivalent qualification) (Scientific Officer grade) in the Aerodynamics and Structures Departments of the Royal Aircraft Establishment, South Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.596/51A.

Assistant Physicist (degree in physics essential and hospital experience desirable) in Radiotherapy Centre—The Secretary, War Memorial Hospital, Scunthorpe.

Assistant Physicist (Assistant Experimental Officer grade)—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/1.

Biochemist (medical qualification is not essential, but experience in hospital biochemistry is necessary)—The Secretary, Harrogate and Ripon Hospital Management Committee, Hereford Lodge, Cornwall Road, Harrogate.

Chief Computer (with a first- or second-class mathematics degree and thoroughly conversant with modern computing methods, including the use of punch card machines) for the Theoretical Physics Branch—File 11A, National Research Council, Atomic Energy Project, Chalk River, Ont., Canada.

Development Engineer at the Capenhurst Factory, Chester, to assist in the organization of a development team engaged on the construction, operation and maintenance of prototype plants involving both mechanical and chemical engineering—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 288.

Director of Research (fully qualified and experienced research chemist, preferably with a practical knowledge of the chemistry and technology of rubber and fatty oils)—The Accountant Secretary, Factice Research and Development Association, York House, 12 York Street, Manchester 2.

Experimental Biologist (qualifications in physiology, zoology or biochemistry essential) in the Pathology Department—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middx.

Experimental Officer, Mineral Resources (Research) Committee, Uganda, to carry out detailed examination of mineral deposits of specific areas, etc.—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting *Nature*, 27079/60/51.

Experimental Officers in the Radio Department of the Royal Aircraft Establishment, Farnborough: Senior Experimental Officer (Ref. A.405/51A) to work on development of air and ground transmitters on V.H.F. and decimetre wave-lengths and of various power levels, an Experimental Officer (Ref. D.579/51A) for work on the development of radio control and telemetering equipment and for supervision of relevant development contracts with industry, an Assistant Experimental Officer (Ref. D.58 /51A) for control tower work, and Assistant Experimental Officers (Ref. A.406/51A) for laboratory work on aeronautical radio communication, navigation and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Government Chemist under the Government of Tripolitania—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.966/51A.

Graduate Physicists or Electrical Engineers, for work in connexion with electrical and electronic instruments and for extended research programme on thermionic emission—The British Scientific Instrument Research Association, Southill, Chislehurst, Kent.

Graduates (with first- or second-class honours in physical chemistry or physics) for fundamental work on combustion of solid fuels—The Assistant Secretary (Ref. A.2), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

Head (with a good honours degree and experience in the development of operations and processes from the laboratory to the commercial scale) of the Chemical Engineering Section—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

Head of the Department and Provincial Agricultural Economist—The Registrar, The University, Nottingham.

Lecturer in Mathematics at the College of Arts and Sciences, Baghdad—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.29012.C.

Lecturer or Assistant Lecturer in Chemistry (with special qualifications in inorganic chemistry)—The Secretary and Registrar, University College, Southampton.

Lecturer or Assistant in Production Engineering—The Principal, Technical College, Corporation Street, Preston.

Lecturer to take charge of the Mining Department—The Principal, Technical College, Longport, Canterbury.

Mechanical and Electrical Engineers in the Air Ministry Works Department, in connexion with the design, operation and maintenance of ground mechanical and electrical works services on R.A.F. stations at home and overseas and on Civil Aviation stations—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.19/48A or D.370/50A.

Physicists (with Ph.D. or equivalent, preferably in engineering physics) for work in electronics, physical measurements and X-Ray diffraction, an Organic Chemist (with Ph.D. or equivalent, and preferably special training or experience in wood, cellulose or carbohydrate chemistry), and an Inorganic or Physical Chemist (with Ph.D. or equivalent, and preferably special training or experience in metallurgy, electrochemistry or corrosion)—Dr. G. M. Shrum, Acting Director, British Columbia Research Council, Vancouver 8, B.C., Canada.

Routine Bacteriologist (B.Sc. qualification necessary)—The Secretary, Lister Institute of Preventive Medicine, Elstree, Herts.

Science Graduate (with experience in clinical biochemistry) to work on metabolic studies at the Institute of Orthopædics, Royal National Orthopædic Hospital, Stanmore, Middx.—The Secretary, Institute of Orthopædics, 234 Great Portland Street, London, W.1.

Scientific Officers at a Ministry of Supply Design Establishment in Surrey: Physicist (Ref. A.308/51A) preferably with interest in statistics, to plan, supervise and report full-scale field trials, which often involve optical and electrical instrumentation, etc., Physicists (Ref. A.307/51A) for general physical investigations and for work connected with fire control equipment, a Mechanical Engineer (Ref. C.644/51A) with aptitude for applied mathematics, for work on vibration, stress and thermodynamics, and a Mechanical Engineer preferably with electrical bias and workshop experience, for general mechanical research and development, and Electrical Engineers (Ref. D.466/51A) for the application of electrical and electronic techniques to engineering problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Scientific Officers in the Radio Department of the Royal Aircraft Establishment, Farnborough: Senior Scientific Officer (Ref. A.394/51A) to work on research and development of airborne and ground radio navigation equipment and the supervision of relevant development contracts with industry, a Scientific Officer (Ref. A.395/51A) for experimental work on new techniques and systems for communications, navigation and radio control, using V.H.F., and a Scientific Officer (Ref. A.396/51A) for research on electro-acoustic problems occurring in aviation, including voice transmission in the presence of high noise levels, and measurement and assessment of microphone and telephone performance—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

University Graduates in mathematics, physics, engineering or geography (including geodesy) as Surveyors in H.M. Colonial Service, New Hebrides—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting *Nature*, 27076/30/51.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Growing Wool. Pp. 44. 2*s*. Making Wool Fabrics. Pp. 26. 1*s*. 6*d*. (London: International Wool Secretariat, 1951.) [3078]

Directory of Free Lance Journalists, Artists and Photographers. Pp. 52. (London: National Union of Journalists, 1951.) [3010]

Imperial Forestry Institute. Institute Paper No. 27: A Comparative Study of some of the More Important Mechanical and Physical Properties of Trinidad and Burma Grown Teak (*Tectona grandis* L.). By R. Smeathers. Pp. 19+1 plate. (Oxford: Imperial Forestry Institute, 1951.) 2*s*. 6*d*. [3016]

British Museum (Natural History). A Short Guide to the Exhibition Galleries of the Natural History Museum. Pp. v+25. (London: British Museum (Natural History), 1951.) 9*d*. [3119]

Bulletin of the British Museum (Natural History). Zoology, Vol. 1, No. 6: The Ocean Sunfishes (family Molidæ.) By A. Fraser-Brunner. Pp. 87–121. (London: British Museum (Natural History), 1951.) 7*s*. 6*d*. [3118]

Other Countries

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien. Band 2, No. 1: Die Diatomeen von Schweden und Finnland. Von Astrid Cleve-Euler. Pp. 163+56 plates. 40 kr. Fjärde Serien, Band 2, No. 2: On some Osteolepiform Crossopterygians from the Upper Old Red Sandstone of Scotland. By Erik Jarvik. Pp. 36+10 plates. 12 kr. Fjärde Serien, Band 2, No. 3: Photographic, Photovisual and Red Magnitudes in the Galactic Cluster M.36. By Erik Bodén. Pp. 28. 3.25 kr. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1951.) [2991]

Canada: Department of Resources and Development, National Parks Branch. National Museum of Canada, Bulletin No. 121 (Biological Series No. 41): Botany of Southeastern Yukon adjacent to the Canol Road. By A. E. Porsild. Pp. v+400 (39 plates). (Ottawa: King's Printer, 1951.) 1 dollar. [3011]

Racial Myths. By Prof. Juan Comas. (Race Question in Modern Science Series.) Pp. 52. Race and Culture. By Michel Leiris. (Race Question in Modern Science Series.) Pp. 46. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 1*s*. 6*d*.; 25 cents; 75 francs each. [3019]

Smithsonian Miscellaneous Collections. Vol. 115: Biological Investigations in Mexico. By Edward Alphonso Goldman. (Publication 4017.) Pp. xiii+476+71 plates. (Washington, D.C.: Smithsonian Institution, 1951.) [51]